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Related to the Silicate Industries

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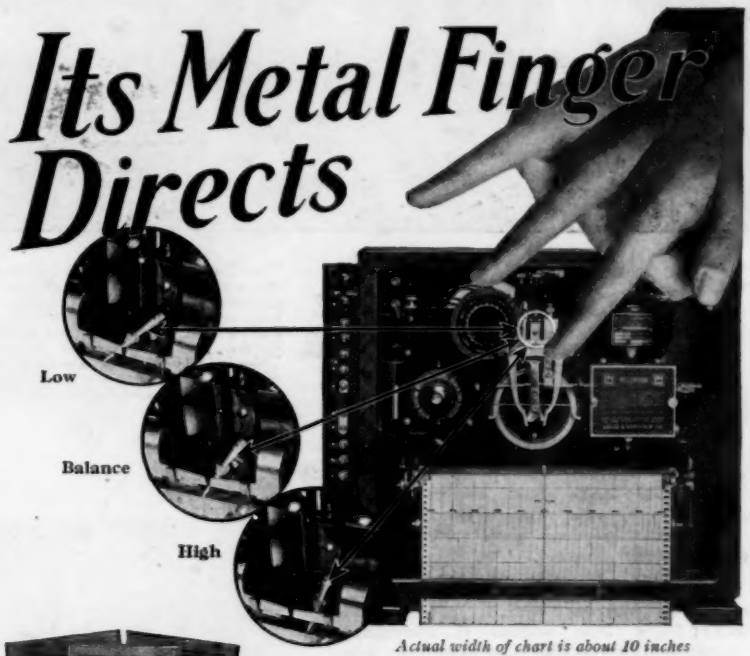

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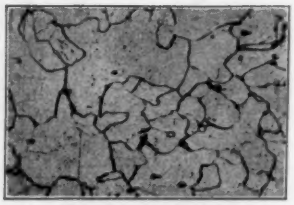

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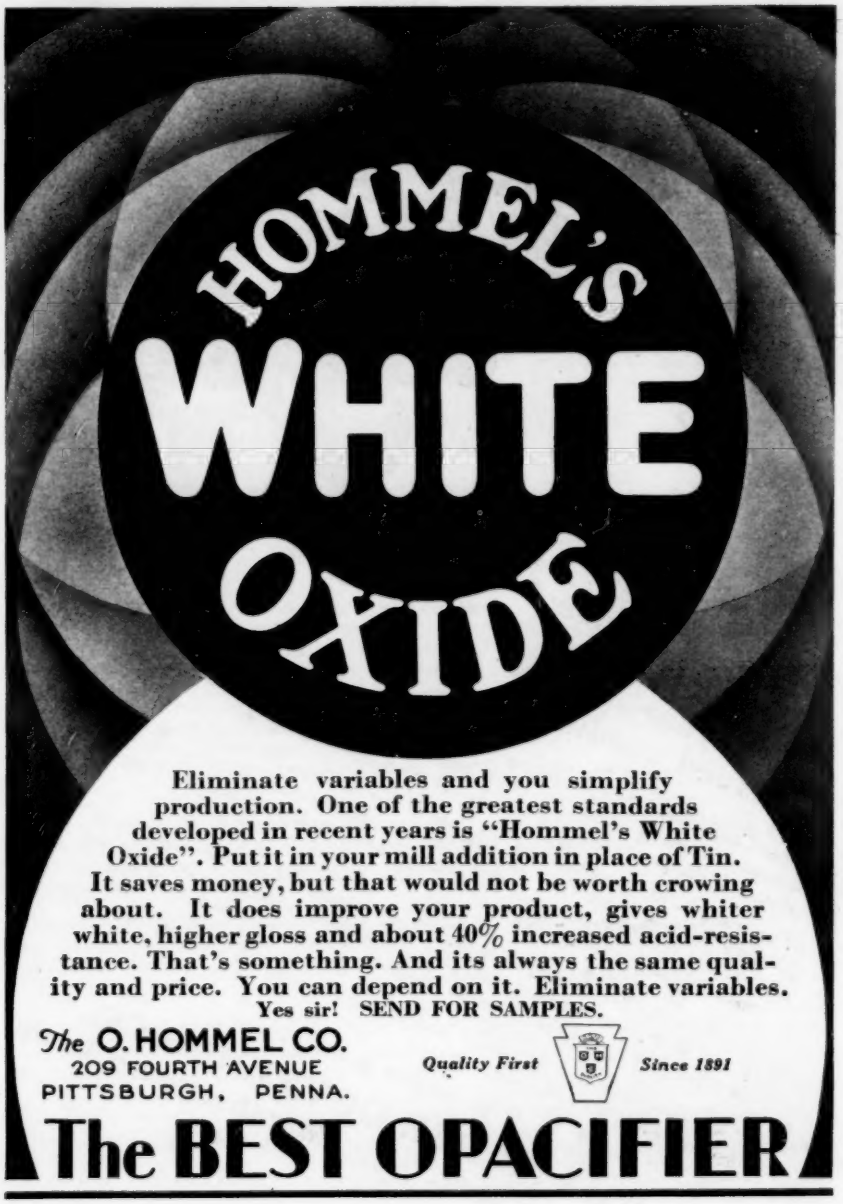
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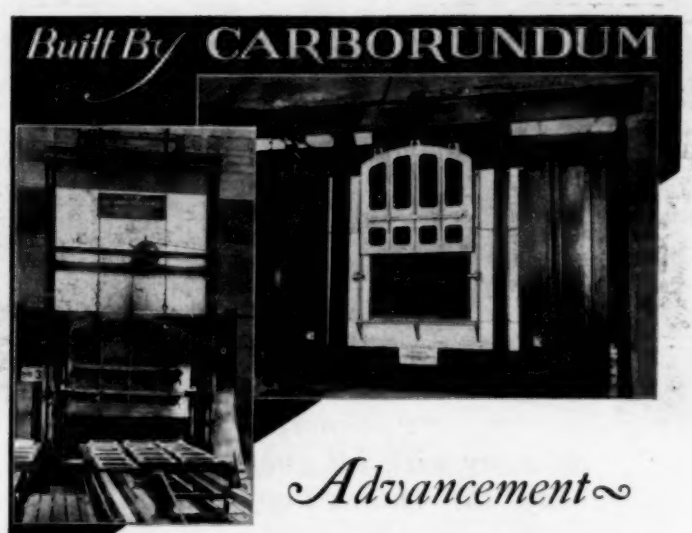

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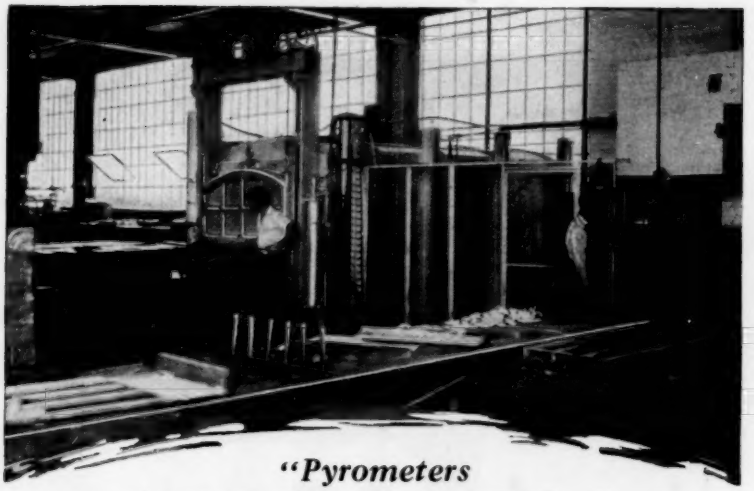

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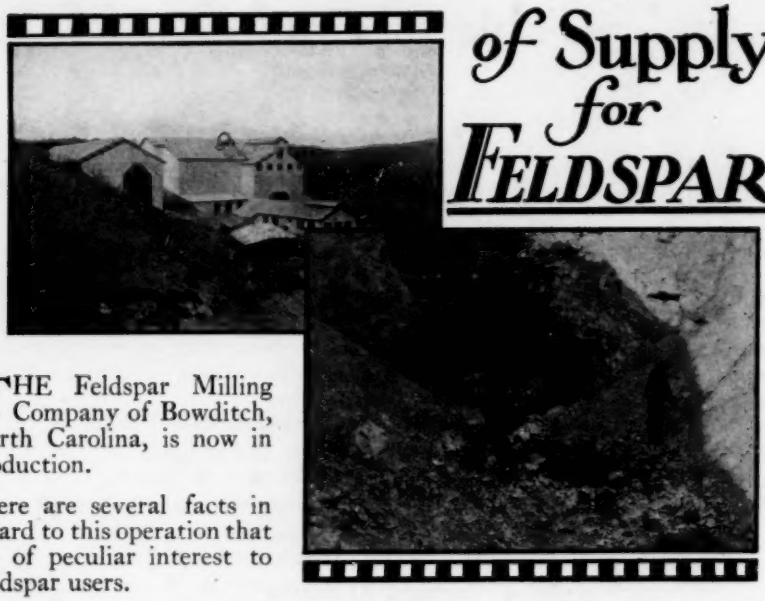

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RATE OF DRYING OF A PLASTIC PORCELAIN MASS DUE TO REDUCED PRESSURE AND HEAT[1]

By Louis Navias

ABSTRACT

Experiments in drying plastic porcelain masses are performed using reduced pressures of 0.7, 5, 15, and 35 cm., with surrounding temperatures of 23, 50, and 65°C. Plotting the logarithm of the loss of weight against the logarithm of time, straight-line relationships are found to exist for the drying rate. With the lowest pressure a single slope is found, whereas with the three higher pressures there are two slopes to each curve. The lowering of the temperature of the whole mass with lowering in pressure is shown. Effect of shape of specimen and humidity of air on rate of drying is discussed.

Theory of Drying

Steger[2] gives a rather complete picture of the mechanism involved in first wetting and then drying a clay mass, and it is of interest to summarize his views here.

Wetting a Dry Clay Mass

Clay particles are considered to be porous, that is, each individual particle contains pores.

(1) The first addition of water (*a*) to a dry clay mass goes to filling these particle-pores.

(2) A second addition of water (*b*) will give each particle a surface film of water which may be treated as an adsorbed layer around each particle. The sum ($a + b$) is known as the capillary water.

(3) A third addition of water (*c*) goes to fill the voids between the clay particles. These voids constitute the inter-particle spaces. At this stage of the wetting the clay mass is rigid and nonplastic.

(4) Further addition of water causes the clay mass to swell and to become plastic. The water causes the hydrates of the clay particle to absorb water and increase in size. The water layer separates the clay particles and becomes the continuous phase. The suitable addition of water (*d*) to give a plastic mass of normal consistency may be considered as the water of plasticity.

(5) The total addition of water (*e*) required to give a plastic mass of normal consistency may then be subdivided into the categories given above,

$$e = a + b + c + d$$

or using the nomenclature adapted above, the total water addition for normal consistency goes (*a*) to fill the particle pores, (*b*) to coat each particle with an adsorbed layer of water, (*c*) to fill the inter-particle spaces, and (*d*) to float the clay particles apart with the water of plasticity.

Drying a Plastic Clay Mass

In drying, the operations indicated in the wetting process are reversed in order, there being two main periods:

---

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (White Wares Division.) Received December 6, 1928.

[2] Steger, "The Theory of Drying," *Tonind. Ztg.*, **50**, 28 (1927).

(1) The removal of the water of plasticity (d) causes the clay mass to become rigid and nonplastic. The loss in weight is proportional to the time of drying, the rate of evaporation of the water from the clay being proportional to the difference between the saturated vapor pressure existing at the temperature of the clay and the vapor pressure of the air. A point in the drying is reached where no more moisture is lost, although water is present in the mass.

(2) With water of plasticity removed, the vapor pressure of the clay mass is now no longer equal to the saturated vapor pressure of water at the temperature of the clay, but actually lower. In order to remove the moisture content ($a + b + c$), the vapor pressure of the clay mass must be raised by heat. The loss is accomplished in the order, c, b, a.

Interference with Drying by Entrapped Air

Brand[3] also gives a rather similar description of the processes of wetting and drying of a clay mass. During the removal of the water of plasticity or water of moldability (d) the main shrinkage occurs, and accompanying it the cracking of the clay mass if the drying is not

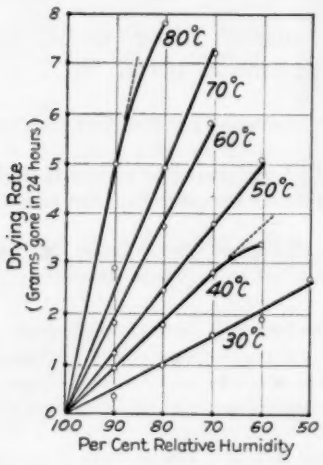

FIG. 1.

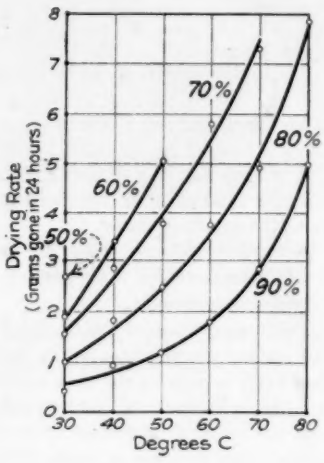

FIG. 2.

carried on properly. Only after the total shrinkage occurs, does capillarity come into play in removing the moisture content ($a + b + c$).

In discussing the question of "air as cause for drying cracks" Brand indicates that air entrapped in the clay is a serious hazard to good drying, for the bubbles of air are found in the heavy film of water between clay particles constituting the water of plasticity (d). By interrupting and interfering with the flow of moisture to the surface of the clay mass where evaporation takes place, the bubbles of air cause differential drying resulting in strains which develop cracks.

[3] J. F. F. Brand, "De-Airing as Corrective in Drying," *Jour. Amer. Ceram. Soc.*, **9**, 189–96 (1926).

Factors Affecting Rate of Drying

The factors involved in the evaporation of moisture from a clay mass are well given by Lindsay and Wadleigh.[4] Other factors remaining constant:

(1) The rate of evaporation increases, with rise in temperature of the air, due to increase of effective vapor pressure in the material.

(2) The rate of evaporation decreases with rise in wet-bulb temperature of the air due to the corresponding rise in relative humidity and corresponding reduction in the difference between the vapor pressure in the material and the vapor pressure in the air.

(3) The rate of evaporation decreases after shrinkage water has been removed, with decrease in moisture content, due to demonstrated decrease in effective vapor pressure in the material.

(4) The rate of evaporation is increased by increasing the exposed surface area per unit weight of clay mass.

These authors then consider the "effect of the rate of evaporation upon clay" using experimental evidence. A discussion of the types of drying faults includes: (1) warping and cracking, (2) checking, (3) laminations, (4) strains, and (5) sticking.

Drying of Clay under Definite Conditions

Troop and Wheeler[5] have carried on some very interesting quantitative experiments by allowing the drying of a clay mass to proceed from one surface only. The temperature was varied from 30 to 80°C and the relative humidity from 50 to 90%, with a constant air velocity of 1.5 to 2 ft. per minute. The specimen of clay was in the form of a cylinder 5 inches long and 1 inch in diameter, the evaporation taking place at one end of the cylinder.

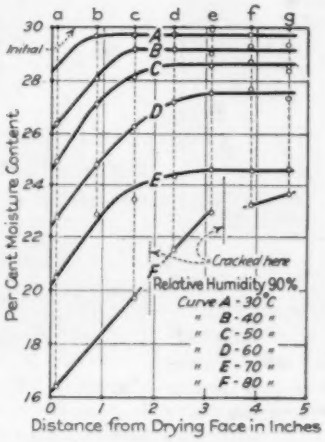

FIG. 3.—Water distribution in cylinders; 24 hours' drying.

Under these restricted conditions the drying process may be represented by the equation

$$-W = A(Ps - Pd)$$

where W = rate of evaporation in kg. per square meter of surface per hour

$A = a\left(1 + \frac{v}{b}\right)$ a factor dependent on the velocity of air

v = velocity of air in meters per sec.; a and b are constants.

A varies with temperature and relative humidity, an average value being 0.0158

[4] D. C. Lindsay and W. H. Wadleigh, "Some Observations on Drying Properties of Clays," *Jour. Amer. Ceram. Soc.*, **8**, 677–93 (1925).

[5] R. S. Troop and F. Wheeler, "Drying of Clay under Definite Conditions," *Trans. Ceram. Soc.* (Eng.), I and II, **26**, 231–48 (1926–27); III, **26**, 261–75 (1926–27).

Determinations were also made to find the distribution of water in the clay mass along the length of the cylinder after 24 hours' drying, maintaining the relative humidity at 90% and varying the temperature between 30°C and 80°C. Three of their graphs are reproduced as Figs. 1, 2, and 3.

Use of Reduced Pressures in Drying (Experimental)

While reduced pressures have been used in the chemical industry for drying purposes, little or no use has been made of reduced pressures in the drying of plastic masses containing clays. The experiments described in this paper were undertaken to determine how drying is accomplished under reduced pressures, at varying temperatures of the surrounding air.

A plastic porcelain body was used containing

	(%)
China clay	20
Ball clay	25
Flint	25
Feldspar	30

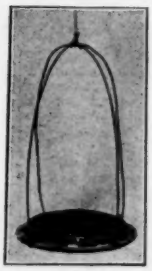

FIG. 4.—Metal base for apparatus for determining rate of moisture loss during evacuation.

As the plastic body contains 55% of nonplastic material the conditions of drying are not exactly similar to the conditions prevailing where the mass consists of clays alone. The average moisture content of the plastic porcelain masses was 25% when calculated on a dry-weight basis, or 20% on the original wet weight.

Apparatus and Set-up The most successful set-up of apparatus is described and shown in Figs. 4, 5, and 6.

Glass Cell The plastic clay mass is supported inside a glass cell by means of a wire tripod network hanging from a molybdenum wire hook fused into the Pyrex glass cell. The cell fits into a ring depression made in the copper base plate, the ring depression being filled with de Khotinsky cement, or better still with ordinary 50–50 solder for the higher temperatures. The cell and contents are supported from one arm of a balance by means of the wire framework attached to the base plate.

The two glass tube arms of the cell are connected with flexible pressure hose to mercury manometers and the other devices. The hose members are maintained in a horizontal position by two clamps appropriately placed to allow the cell to hang truly vertical from the balance arm, and to give adequate play to the cell for balancing purposes. If the hose is not properly adjusted the cell will gain or lose weight when the internal pressure of the cell is reduced, due to contraction of the rubber hose.

Temperature Measurements The temperature of the plastic mass in the cell is measured by means of a thermocouple of very fine wire, which enters the system through one glass tube arm where it is cemented into place. The fine wires are insulated with rubber tubing. The hot junction of the thermocouple is embedded in the plastic mass where the temperature is to be read. The fine wires do not interfere with the balancing of the system.

The temperature of the air in the cell around the plastic mass is determined by means of a slender mercury thermometer lying in the inlet side arm with the bulb just inside the cell.

Oven around Cell For temperatures above room temperature the hanging system is inclosed in an oven heated by means of a small electric heater placed at the bottom of the oven and a few inches below the base plate of the cell. Thermometers placed at the top and middle of the oven serve to indicate the temperature distribution.

The heating of the air for the system is accomplished by putting a double grid of glass tubing between the heater and cell in the oven, and leading the cold air through the glass grid where the air is heated to the proper temperature before entering the cell. The temperature of the heated air entering the cell is measured by the thermometer in the side arm.

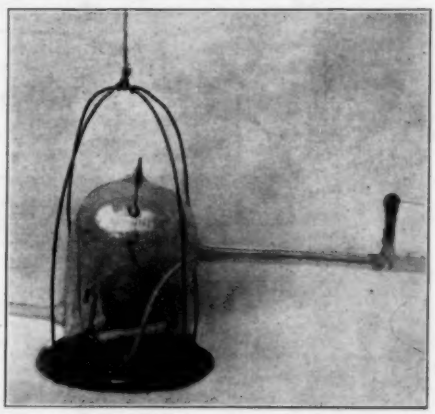

FIG. 5.—Apparatus for determining rate of moisture loss during evacuation.

Pressure Measurements The reduced pressure is obtained by connecting the system to the rough vacuum line in the laboratory, which usually maintains a pressure of 0.3 cm. Manometers of the U-type were used, there being one on the inlet side and another on the outlet side of the cell. The pressures indicated in this paper are those recorded by the gage near the vacuum side of the system.

To obtain the low pressure of 1 cm. or less, the inlet end is closed completely, hence there is no flow of gas through the system other than the moisture from the sample in the cell. For the pressures of 5, 15, and 35 cm. the inlet stop-cock had to be opened. An estimate of the air flow through the system was obtained in a subsequent study by determining the time required by the suction of the system to fill an inverted graduated

cylinder as it was lowered into a container of water, the water levels inside and outside the graduate being maintained even. The flow of air was then calculated to be 7, 25, and 60 cu. cm. per second for pressures of 5, 15, and 35 cm., respectively. The general effect of increasing the pressure is thus seen to be that of an increase in air velocity.

Weighing The balance is sensitive to 0.1 g. with the system in place. The balance comes to rest in a short space of time due to the damping effect of the rubber hose clamped in the two positions.

Air Conditioning In some experiments the air as existing in the atmosphere was allowed to flow through the system. Wet- and dry-bulb thermometer measurements of the atmosphere in the room indicated relative humidity conditions of 55 to 65%. In other ex-

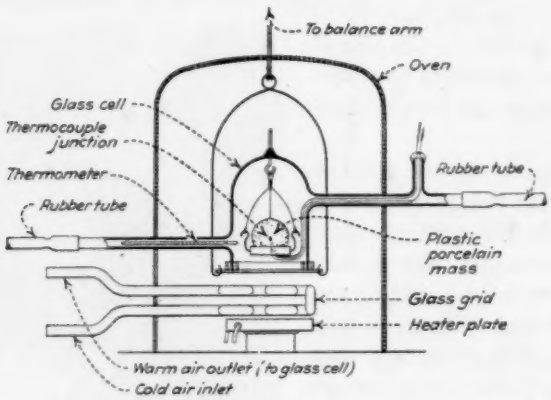

FIG. 6.

periments the air was thoroughly dried by passing it through a series of bottles containing phosphorus pentoxide.

Experimental Procedure The assembling of the cell is rather troublesome, but can be accomplished with experience and made vacuum tight. The base plate with solder in the ring depression is heated until the solder is just fluid, when the glass cell with plastic mass in position is lowered into the solder. The base plate is then quickly chilled to prevent heating of the plastic porcelain mass. The suspension of the cell and the rest of the assembly does not take much time.

As soon as the initial conditions for the experiment are attained, the loss in weight of the system is recorded against time, and the relationship between time and loss of moisture constitutes the main evidence.

The plastic mass was weighed after shaping and before being put in the cell, usually weighing 134 g. In most cases the mass after drying was weighed, and the percentage loss in weight compared with a second speci-

men sampled for determining directly the total moisture lost by heating in an oven at 110°C.

Experimental Data and Calculations

As an illustration the data and calculations for Experiment 9 are given in some detail in Table I and the summarized results for all experiments in Table II.

TABLE I
(Experiment 9)

Ball of plastic porcelain	134.0 g.
Temperature in cell	54 to 58°C
Pressure in system	5 cm. Hg
Atmospheric air passed through system	

Initial Period

Experimental determinations		Calculated values	
		$a = 0.83$	
Time in hours t	Loss of moisture in g. ω	$t^{0.83}$	$\frac{\omega}{t^{0.83}}$
0.25	2.5	0.32	7.82
0.50	3.6	0.56	6.42
0.75	5.2	0.79	6.60
1.00	6.4	1.00	6.40
1.25	7.5	1.20	6.25
1.50	8.4	1.40	6.00
1.75	9.6	1.59	6.03
2.00	10.6	1.78	5.96
2.25	11.7	1.96	5.97
2.50	12.7	2.15	5.91
2.75	13.7	2.32	5.91
3.00	14.6	2.50	5.83
3.25	15.8	2.67	5.92
3.50	16.9	2.84	5.94
3.75	18.1	3.01	6.02
4.00	19.0	3.18	5.97
4.25	20.1	3.34	6.02
4.75	21.9	3.64	6.01
Mean of 13 values (1.50–4.75 hr.)			5.96 ± 0.8%

Final Period

		$a = 0.46$	
		$t^{0.46}$	$\frac{\omega}{t^{0.46}}$
5.00	22.4	2.10	10.67
5.25	23.1	2.14	10.79
5.75	24.4	2.24	10.89
6.25	25.2	2.32	10.85
6.75	25.9	2.41	10.74
7.00	26.2	2.45	10.70
7.25	26.8	2.49	10.77
7.50	27.1	2.53	10.72
7.75	27.7	2.56	10.82
Mean of 9 values (5.00–7.75 hr.)			10.77 ± 0.6%

Determination of Constants (a and constant $\frac{\omega}{t^a}$)

On plotting the actual loss of weight in grams or the percentage loss of weight against time on log-log paper, straight-line relationships are found to exist. The slope $a = \frac{\log \omega}{\log t}$ may be determined graphically

TABLE II

SUMMARIZED RESULTS

Expt. no.	Shape of sample	Pressure in system, cm.	Temperature (°C)		Condition of air passing through system	Total time for expts. (hr.)	No. of readings	
			In cell	At center of mass			Initial period	Final period
12	Ball	0.5-0.7	19–22	1–4	None	(17.2)	25	
13	"	0.7–0.8	62–65	9	"	5.1	14	
14	Disk	0.7-0.8	62–65	10	"	3.75	10	
18	"	0.7–0.9	67–68	12–14	"	4.25	10	
5	Ball	5	(23)		Atmos.	17.2	15	8
9	"	5	54–58		"	7.75	13	10
2	"	15	(23)		Dry	(8.25)	12	nd
6	"	15	(23)		"	13.7	11	7
4	"	15	(23)		Atmos.	16.8	12	13
7	"	15	46–55		"	8.25	10	11
1	"	35	(23)		Dry	(7.25)	10	nd
10*a*	"	35	54		Atmos.	5.75	11	7
10*b*	"	35	50–52		"	4.75	9	6

Calculated Values

Expt. no.	Initial period			Final period			Loss of Moisture: Initial period			Loss of Moisture: Final period		
	Time interval (hr.)	a	$\frac{a}{t^a}$	Time interval (hr.)	a	$\frac{a}{t^a}$	Time interval (hr.)	Loss (%)	Loss per hour (%)	Time interval (hr.)	Loss (%)	Loss per hour (%)
12	0.6–17.2	0.6	4.37±1.4%				About 17		About 6			
13	0.85–5.1	0.7	8.72±1.7%				5.1	100	19.6			
14	1.25–3.75	0.8	9.81±1.7%				3.75	100	26.7			
18	1.5–3.75	0.8	9.18±1.1%				4.25	100	23.5			
5	1.8–10.6	0.6	5.92±0.9%	11.2–15.9	0.33	10.92±0.8%	11.2	90	8.1	6.0	10	1.7
9	1.5–4.75	0.83	5.96±0.8%	4.75–7.75	0.46	10.76±0.6%	4.75	79	16.6	3.0	21	7.0
2	(0.75–8.25)	0.75	4.87±2.9%	(Not determined)			(8.25)	(87)	(10.5)	(Not determined)		
6	1.5–7.0	0.75	5.15±0.8%	8.0–12.0	0.33	11.83±0.8%	7.0	81	11.6	6.0	19	3.2
4	0.75–7.75	0.9	3.31±1.6%	8.9–12.4	0.33	10.93±0.7%	8.0	81	10.1	8.0	19	2.4
7	2.0–4.75	0.9	5.49±0.9%	5.5–8.25	0.25	15.57±0.4%	5.0	88	17.6	3.3	12	3.7
1	(1.0–7.25)	0.75	4.00±2.3%	(Not determined)			(7.25)	(72)	(10)	(Not determined)		
10*a*	0.25–2.75	0.9	7.48±1.3%	3.0–5.0	0.6	10.14±0.7%	2.75	69	25	3.0	31	10.3
10*b*	0.5–2.5	0.83	9.6 ±1.3%	2.75–4.0	0.6	11.62±1.5%	2.5	80	32	2.25	20	8.9

from the curve. It may be checked (1) by determining the ratios between log ω and log t, where ω = loss of moisture in grams and t = time in hours; (2) by determining the best constant a, which will in turn give the best constant, $\frac{\omega}{t^a}$, using the percentage average deviation from the mean as the criterion. Attention must be paid to the characteristics of the logarithms. All three methods were employed to determine the constant a.

The constant $\frac{\omega}{t^a}$ is determined for each moisture loss-time reading and the percentage average deviation from the mean for the values representing each slope (initial or final period of dehydration) indicates the true approximation to a straight-line relationship.

In Experiment 9, two straight-line curves are obtained, the value of a for the initial period being 0.83 and the value of a for the final period being 0.46. Under the columns headed "Calculated values" are given the corresponding values of t^a and $\frac{\omega}{t^a}$.

The required initial conditions in the experiments are not usually immediately attained, especially where the air is heated. As a result a number of readings will give points on the curve which deviate from the straight-line logarithmic relationships otherwise found.

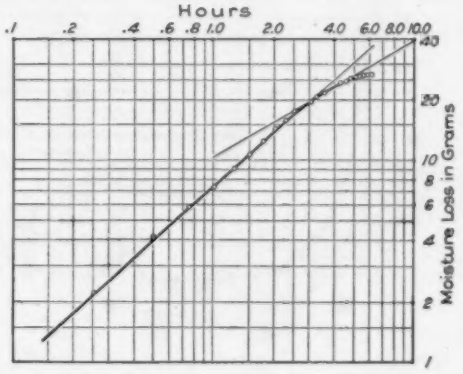

FIG. 7.—Experiment 10*a*. 134 g. plastic porcelain (ball); 35 cm. pressure; 54°C temperature around specimen.

The graph for Experiment 10*a* is given in Fig. 7 to illustrate the two straight-line curves obtained covering the initial and final periods of drying.

Percentage Loss of Moisture per Hour

The average rate of loss of moisture per hour can be calculated for each period of drying and used as a general criterion of drying. In Experiment 9, 79% of the moisture loss occurred in the initial period at the average loss of 16.6% per hour, whereas the remaining 21% moisture loss occurred in the final period at the rate of 7.0% per hour. It should be remembered that the per cent loss per hour in any given period is not a uniform loss distributed over the period. The straight-line relationship exists only between the logarithms of the values for loss and time.

Discussion of Results

(1) Slope a $\left(=\frac{\log \omega}{\log t}\right)$ As the rate of loss of moisture increases, the value of a increases. For the initial periods a varied between 0.6 and 0.9; for the final periods a varied between 0.25 and 0.6.

(2) Constant $\frac{\omega}{t^a}$. For a given value of a as the rate of loss of moisture increases the value of the constant $\frac{\omega}{t^a}$ increases.

(3) Effect of Shape of Test Specimen on Drying Rate (Ball and Disk) (Experiments 13 and 14) Under the same conditions of temperature and pressure, the specimen with the larger exposed surface will dry the faster. The disk lost weight at the rate of 26.7% loss of moisture per hour, whereas the ball lost at the rate of 19.6% loss per hour. For the disk, a has a greater value

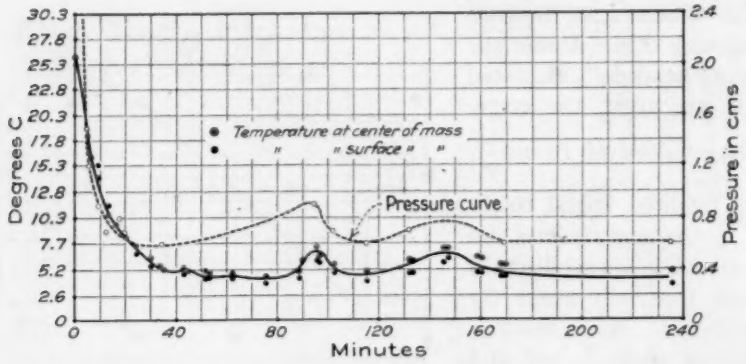

FIG. 8.—Variation of temperature of a plastic porcelain mass with external pressure.

than for the ball. The ball maintained a lower temperature at its center than the disk, over the greater part of the time of experiment.

(4) Relation between the Pressure in the System and Temperature of Plastic Mass The temperature of the mass follows closely the pressure existing in the system. The changes of pressure and temperature with time are plotted in Fig. 8. The temperature at the center of the ball was measured by means of a thermocouple embedded in it. The rapid evaporation caused by the lowering of the pressure lowers the temperature of the plastic mass. If the pressure is now increased a little, the range in pressure between the vapor pressure of the moisture in the plastic mass and the pressure around the specimen is extended, and less moisture is evaporated. Or in other words, the rate of evaporation decreases and the temperature

of the specimen accordingly rises. On lowering the pressure the reverse condition is obtained.

As the water content of the mass approaches zero, the temperature of the specimen rises rapidly to assume the temperature of the surrounding atmosphere. Several curves are shown in Fig. 9.

Under equilibrium conditions the vapor pressure and temperature of a body of water are definitely connected, and on fixing one variable the other is fixed also. The literature gives the following values:

Temp. (°C)	Vapor pressure (cm.)	Temp. (°C)	Vapor pressure (cm.)
0	0.46	15	1.27
5	0.65	20	1.74
10	0.91	25	2.35

From Fig. 8 it will be seen that a vapor pressure of 0.6 cm. around the plastic porcelain mass corresponded to a temperature of 4 to 5°C of the mass.

A similar correspondence will be found for the temperatures of the plastic porcelain masses and the pressures attainable in Experiments 12, 13, 14, and 18, in spite of the high surrounding temperatures existing in Experiments 13, 14, and 18.

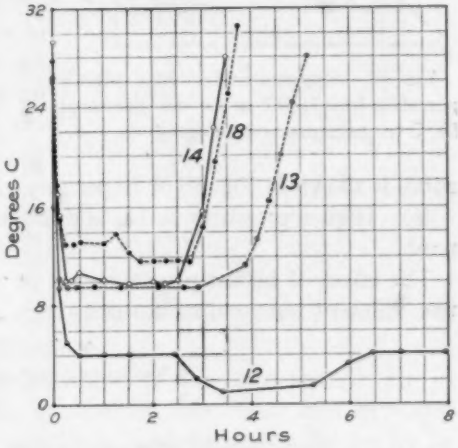

FIG. 9.—Temperatures at center of plastic porcelain mass during evacuation; pressure in system 0.5 to 0.9 cm. of Hg.

Expt. no.	Shape of specimen	Temperature around specimen (°C)
12	ball	19–22
13	ball	62–65
14	disk	62–65
18	disk	67–68

Other experiments on plastic porcelain masses with reduced pressures (following the appearance of Spurrier's paper on "Continuity in Plastic Bodies")[6] showed that the weight of the mass (and surface area) had a great deal to do with the rate at which the lower temperatures were attained on evacuation of the plastic mass. A plastic ring shape 6 inches in diameter, 3 inches high, and a wall thickness of 2 inches on evacuation for 10 minutes decreased from 24 to 20°C. Yet a slice of these rings only $^1/_2$-inch high cooled to 10°C in 10 minutes time of evacuation.

[6] H. Spurrier, "Continuity in Plastic Bodies," *Jour. Amer. Ceram. Soc.*, 9 [8], 535–40 (1926).

(5) Effect of Reduced Pressures on the Drying Rate

(*a*) Very low pressures (less than 1 cm.) (no air passing through the system). With the surrounding temperature maintaining itself around room temperature, the plastic mass assumes a low temperature between 1 and 4°C. Under these conditions the rate of loss of moisture is low, about 6% per hour. (Experiment 12.)

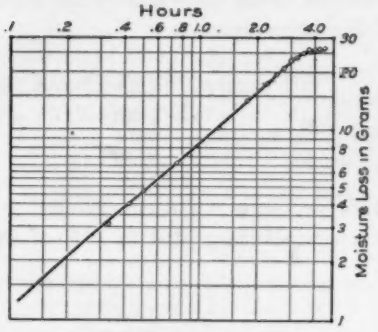

FIG. 10.—Experiment 18, 134 g. plastic porcelain (disk); 0.7 to 0.9 cm. pressure; 68°C temperature around specimen.

As heat is applied to maintain the surrounding air at a temperature higher than room temperature, 64 to 70°C, the temperature of the plastic mass is also maintained at a higher temperature, 9 to 14°C. The rate of loss of moisture is accordingly increased to 20 to 27% per hour. (Experiments 13, 14, and 18.)

There appears to be only one period of evaporation with the same slope for the entire process. As the values for *a* vary between 0.6 and 0.8 they are listed with the initial periods of the other experiments. A typical curve is shown in Fig. 10 of Experiment 18.

(*b*) Higher pressures 5, 15, and 35 cm. (air flowing through the system).

The effect of higher pressures can be seen from Tables III and IV for two different temperature ranges.

TABLE III
SHAPE OF SPECIMEN-BALL

Expt. no.	Pressure (cm.)	Temp. of air (°C)	Condition of air	Rate of loss of moisture per hour: Initial period (%)	Rate of loss of moisture per hour: Final period (%)
12	0.6	19–22		6.0	
5	5	23	Atmospheric	8.1	1.7
2	15	23	Dry	10.5	nd
6	15	23	Dry	11.6	3.2
4	15	23	Atmospheric	10.1	2.4
1	35	23	Dry	10.0	nd

There is a general tendency for the rate of loss to increase with increase in pressure, but the increases are rather slight, due to the cooling effect of the reduced pressures.

At these higher temperatures, there is a definite correspondence between the higher pressures and the greater rates of loss of moisture in the initial periods. As the pressures increased, it was shown that there was a corresponding increase in the air velocity through the system.

TABLE IV
SHAPE OF SPECIMEN-BALL

Expt. no.	Pressure (cm.)	Temp. of air (°C)	Condition of air	Rate of loss of moisture per hour: Initial period (%)	Rate of loss of moisture per hour: Final period (%)
9	5	54–58	Atmospheric	16.6	7.0
7	15	46–55	"	17.6	3.7
10*a*	35	54	"	25.0	10.3
10*b*	35	50–52	"	32.0	8.9

(6) Effect of Varying Temperature at Reduced Pressures

The data have been segregated in Table V to show the effect of temperature variations at the different pressures.

TABLE V

Expt. no.	Pressure (cm.)	Average temperature of air (°C)	Rate of loss of moisture per hour: Initial period (%)	Rate of loss of moisture per hour: Final period %
12	0.6	20	6.0	
13	0.6	64	19.6	
14	0.6	64	26.7	
18	0.6	68	23.5	
5	5	23	8.1	1.7
9	5	56	16.6	7.0
4	15	23	10.1	2.4
7	15	50	17.6	3.7
1	35	23	10.0	nd
10*a*	35	54	25.0	10.3
10*b*	35	51	32.0	8.9

Raising the temperature has a marked effect in increasing the rate of loss of moisture.

(7) Dry Air and Atmospheric Air

The relative humidity of the atmospheric air in the room was determined from wet- and dry-bulb thermometer readings, and corresponded to 55 to 65% relative humidity. The dry air was assumed to be dry after passing through a series of bottles containing phosphorus pentoxide.

In Experiments 4 and 6 conditions are alike except for the use of dry air in No. 6 and atmospheric air in No. 4. The rates of moisture loss are not very different for the two experiments, the dry air causing a more rapid evaporation in both the initial and final periods, although the constant a for the dry air is actually greater than the constant a for the atmospheric air.

Other experimental runs not reported here indicated that the dry air was responsible for a greater percentage rate of loss than the atmospheric air.

(8) Single Period and Double Period Drying

These experiments would indicate that drying of the plastic porcelain mass takes place in two stages (with different slopes in the loga-

rithmic rate curves) when the pressure is maintained at 5 cm. or more. Under the conditions of temperature and pressure (above 5 cm.) attained in these experiments, 69 to 90% of the moisture content is removed in the initial period, and the remainder in the final period.

With pressures below 1 cm., the drying appears to occur in one period only, having a single slope in the logarithmic rate curve, irrespective of the temperature involved.

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THE PREDICTION OF SERVICE VALUE FROM LABORATORY TEST DATA[1]

By A. E. R. Westman[2]

ABSTRACT

Accurate prediction of service value is a prerequisite to the devising of methods of control, development, and specification based on laboratory test data. The precision conditions which must be met before such prediction is possible are given in the paper and the difficulties usually encountered in trying to meet these conditions in ceramic work are shown by examples chosen from the field of refractories.

I. Introduction

(1) Preliminary Statement

Adequate methods for the control, development, and specification of ceramic materials by means of laboratory tests can be devised only when accurate prediction of service value is possible. In order to secure accurate prediction, two groups of conditions must be satisfied. The first group includes conditions relating to the applicability and appropriateness of the test in question; the second group includes all precision conditions. It is the purpose of this paper to show the relation between accuracy of prediction and the more important conditions of the second group, conditions which are frequently quite important although they are often neglected. Cases in which the first group of conditions are satisfied ideally will be considered first and then the less ideal cases will be discussed.

The method employed will consist essentially in stating the different situations in statistical terms, making the usual statistical assumptions, and applying statistical equations. The relations obtained will be expressed graphically. Although the ideas discussed can be applied quite generally to a number of materials, products, etc., the particular case of predicting the service value of fireclay brick will be used to simplify the presentation.

(2) Previous Papers

The author has given some consideration to the subject of the present paper and described some of the statistical quantities used in this paper in previous articles[3] in which statistical methods have been used in ceramic problems or their use has been discussed.

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[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Refractories Division.) Received November 10, 1928.

[2] Research Associate in Ceramic Engineering, Engineering Experiment Station, University of Illinois.

[3] "Statistical Methods in Ceramic Research," *Jour. Amer. Ceram. Soc.*, **10** [3], 133–47 (1927); "The Relative Importance of Errors of Sampling and Measurement in Ceramic Research," *Ibid.*, **11** [4], 264–70 (1928); "An Investigation of Checker Brick for Carburetors of Water-Gas Machines" (with C. W. Parmelee and W. H. Pfeiffer), Univ. of Ill., Eng. Expt. Sta., *Bull.*, No. 179, pp. 46–62, 80–85 (1928).

II. Definition of Quantities

(3) Case Considered To illustrate the matter under discussion, the special case of predicting the service values of different brands of fireclay brick when used in furnace installations of a particular type is considered. The group of brands includes all those which are being produced or are apt to be produced in the near future from the fire clays of the United States. A study of the furnace installations in question has resulted in the proposal of a laboratory test. It is specified that five bricks of a brand should be tested by a definite procedure. The only method of determining service value directly consists in placing samples of the brand in question in actual installations and determining their deterioration after a year's operation.

(4) Laboratory Test and Service Values For each brand of brick, there are four values to consider, viz., (1) its true test value, (2) its observed test value, (3) its true service value, and (4) its observed service value. The true test value of a brand may be considered to be the average value obtained by measuring an indefinitely large number of the brick in question, using a method of measurement which is absolutely accurate. The observed test value for the case considered would be the average value obtained by measurement of five bricks of the brand, using the method specified which would be subject to more or less error. The true service value of the brand would be the average value obtained by repeated service tests in a large number of furnaces using large samples and a method of determining deterioration which was absolutely exact. The observed service value would be the value obtained by a service test in a furnace or furnaces as usually carried out by the consumer, using methods of determining deterioration which are subject to error. In the discussion which follows the variate or variable, X, will be used to represent the true test value of a brand, X_o the observed test value, Y the true service value, and Y_o the observed service value. The group of values of X which would be obtained by testing a number of commercially available brands may be considered to be a sample from an indefinitely large number of similarly obtained values which form what is known statistically as a "population" of values. Similarly, populations of values of X_o, Y, and Y_o may be conceived.

(5) Standard Deviations The individual values of X will vary considerably in magnitude. The amount of this variation may be expressed as the standard deviation[4] of the values of X. The symbol σ_x will be used to represent this standard deviation

[4] For methods of estimating standard deviations consult texts on statistics and "Correction of Data for Errors of Averages," W. A. Shewhart, *Bell System Tech. Jour.*, 5 [2], 308–19 (1926).

and the symbols σ_{xo}, σ_y, and σ_{yo} for the standard deviations of the populations of values of X_o, Y, and Y_o, respectively, defined in the foregoing. We shall assume that these populations are "normal" populations,[5] which will be approximately true for many ceramic materials.

(6) Correlation Coefficients The accuracy of prediction of one quantity, B, from a second quantity, A, depends primarily upon the degree of correlation or relationship which exists between A and B. When A and B are quantities which form normal populations, the degree of relationship can best be expressed by means of a coefficient of correlation.[6] Such coefficients will be symbolized by the letter r and subscripts will be used to indicate the quantities correlated, r_{AB}, for example, representing the coefficient of correlation between the quantities A and B. For the four quantities X, X_o, Y, and Y_o defined in the foregoing, the correlation coefficients r_{xy}, r_{xoyo}, and r_{xoy} are of interest in our discussion. Thus, r_{xy} expresses quantitatively the degree of correlation which exists between the true test values of the brands and their true service values; r_{xoyo}, the degree of correlation between observed test values and observed service values; and r_{xoy}, the degree of correlation between observed test values and true service values. Assuming that the correlation is in all cases positive, *i.e.*, that service value increases with test value, these correlation coefficients may take values from zero to $+1$. A value of $+1$ indicates perfect linear correlation, a value of zero shows lack of relationship[7] between the quantities involved, and intermediate values indicate intermediate degrees of correlation.

(7) Standard Deviation of Prediction If A and B are normally correlated quantities and if the coefficient of correlation r_{AB} is known, then for each value of A a corresponding value of B can be predicted. The actual values of B for a large number of individuals having a common value of A will be distributed about their predicted value. The spread of this distribution may be expressed by means of a quantity called the standard deviation of prediction. This gives the range on either side of the predicted value within which about 68% of a large number of actual values may be expected to fall. The symbol, σ_{pyo}, will be used to designate the standard deviation of prediction of Y_o, the observed service value of a brand, from X_o, its observed laboratory test value; and the symbol σ_{py} for the standard deviation of prediction of Y, the true service value of a brand from

[5] See "Statistical Methods in Ceramic Research," *loc. cit.*

[6] Consult texts on statistics for details and also reference 5.

[7] Except for certain nonlinear relationships. See H. L. Rietz, "On Functional Relations for Which the Coefficient of Correlation is Zero," *Quar. Pub. Amer. Stat. Assn.*, **16**, 472–76 (1919).

X_o, its observed laboratory test value. Accuracy of prediction increases when the standard deviation of prediction decreases.

(8) Coefficients of Alienation If the values of Y_o are distributed with a standard deviation σ_{yo} and the standard deviation of the prediction of Y_o from X_o is σ_{pyo}, then the coefficient of alienation[8] for the prediction of Y_o from X_o is σ_{pyo}/σ_{yo} and will be designated by the symbol a_{xoyo}. Thus a_{xoyo} gives the ratio between the variation of the actual values of Y_o for a number of brands having the same X_o and the variation of Y_o for all the brands regardless of their values of X_o. If a_{xoyo} has the value 0.5, then a large number of brands with the same X_o will show only about 50% of the variation in service value which will be shown by a large number of brands selected at random. Coefficients of alienation, therefore, form a useful measure of the value of prediction. The symbol a_{xoy} will be used for the alienation coefficient for the prediction of Y from X_o.

(9) Standard Deviation of Measurement If for any one brand X_o is determined repeatedly, the values obtained can be considered a sample from a population of similarly obtained values which is assumed to be normally distributed and has a standard deviation represented by the symbol σ_{Axo}. Similarly, for any one brand we can define the standard deviation of measurement of Y_o, which we shall designate by the symbol σ_{Ayo}. These standard deviations of measurement should not be confused with the standard deviations defined in Section 5, which included σ_x, σ_{xo}, σ_y, and σ_{yo}. Thus, σ_{Axo} is the standard deviation of the population which is considered to be generated by repeated measurements of X_o made on *one* typical brand, whereas σ_{xo} is the standard deviation of the population of values generated by determining one value of X_o for a large number of different brands of brick chosen at random.

(10) Summary The symbols which have been adopted in the foregoing sections and the quantities which they represent are listed in Table I for convenient reference.

III. Derivation of Relations

(11) Restatement of Purpose The purpose of this discussion was stated in Section 1 to be that of finding the nature and extent of the dependence of the accuracy of prediction of service value from laboratory test data upon the precision with which these quantities were measured. By using the statistical quantities defined in Chapter II, the purpose can be stated more definitely as that

[8] See Truman L. Kelley, "Chart to Facilitate the Calculation of Partial Coefficients of Correlation and Regression Equations." Stanford Univ. Publications, School of Education, Special Monograph, No. 1, p. 10 (1921).

of finding the relations between the error of prediction of Y_o from X_o, as measured by r_{xoyo}, σ_{pyo}, or a_{xoyo}, and the errors of measurement of X_o and Y_o, represented by σ_{Axo} and σ_{Ayo}, when r_{xy} is known. We shall also find these relations for the prediction of true service value, Y, from observed test value, X_o.

(12) Simplification Conditions governing accuracy of prediction which depend on the appropriateness or applicability of the laboratory test are not of primary interest, but it is assumed that these conditions are met ideally and that $r_{xy} = 1.0$. This means that if X and Y could be measured without error perfectly accurate predictions could be made. Also, since σ_x and σ_y are properties of the collection of brands with which we are working, we shall assign them the arbitrary value of unity. The standard deviations of measurements of X_o and Y_o are assumed to be equal and represented by one symbol, σ_A. Thus, $\sigma_A = \sigma_{Ayo} = \sigma_{Axo}$, and will be used to represent errors of measurement. With these simplifications the problem is reduced to that of finding (1) the relation between r_{xoyo}, σ_{pyo}, and a_{xoyo}, on the one hand, and σ_A on the other, when r_{xy}, σ_x, and σ_y have the value unity and $\sigma_{Axo} = \sigma_{Ayo} = \sigma_A$ and (2) the relation between r_{xoy}, σ_{py}, and a_{xoy}, on the one hand, and σ_A on the other, under the same conditions.

(13) Prediction of Observed Service Value from Observed Test Value If the errors which cause the differences between X_o and X, and Y_o and Y are normally distributed and not correlated[9] with the values of X and Y, assumptions which are valid in most engineering work, then r_{xoyo} and r_{xy} will be related as shown by the following equation:[10]

$$r_{xoyo} = \frac{\sigma_x \sigma_y}{\sigma_{xo} \sigma_{yo}} r_{xy} \tag{1}$$

where r_{xoyo}, r_{xy}, σ_x, σ_y, σ_{xo}, and σ_{yo} have the meanings previously given. (See Table I for summary.)

The standard deviations σ_x, σ_{xo}, and σ_{Axo} will be related by the equation[11]

$$\sigma_{xo}^2 = \sigma_x^2 + \sigma_{Axo}^2 \tag{2}$$

and, similarly, σ_y, σ_{yo}, and σ_{Ayo} will be related by the equation

$$\sigma_{yo}^2 = \sigma_y^2 + \sigma_{Ayo}^2 \tag{3}$$

[9] If errors in determining X tend to be positive when errors in determining Y are positive, or if $X_o - X$ is correlated with X, or $Y_o - Y$ is correlated with Y, etc., then this condition will not be completely satisfied.

[10] G. Udney Yule, An Introduction to the Theory of Statistics, 8 ed., p. 213, Charles Griffin and Co., Ltd., London, 1927; and W. A. Shewhart, "The Correction of Data for Errors of Measurements," *Bell System Tech. Jour.*, **5** [1], 1–26 (1926).

[11] G. Udney Yule, *loc. cit.*, p. 211 and W. A. Shewhart (see footnote 10).

TABLE I

LIST OF SYMBOLS

Symbol	Quantity
X	True laboratory test value of a brand
X_o	Observed laboratory test value of a brand
Y	True service value of a brand
Y_o	Observed service value of a brand
σ_x	Standard deviation of values of X
σ_{xo}	" " " " " X_o
σ_y	" " " " " Y
σ_{yo}	" " " " " Y_o
r_{xy}	Coefficient of correlation between X and Y
r_{xoyo}	" " " " X_o and Y_o
r_{xoy}	" " " " X_o and Y
σ_{pyo}	Standard deviation of prediction of Y_o
σ_{py}	" " " " " Y
a_{xy}	Alienation coeff. for prediction of Y from X
a_{xoyo}	" " " " " Y_o from X_o
a_{xoy}	" " " " " Y from X_o
σ_{Axo}	Standard deviation of measurement of typical X_o value
σ_{Ayo}	" " " " " " Y_o value
σ_A	" " " " " X_o and Y_o (assumed equal)

By combining equations 1, 2, and 3, and introducing the conditions $r_{xy} = 1$, $\sigma_x = \sigma_y = 1$, and $\sigma_{Ayo} = \sigma_{Axo} = \sigma_A$, the following equation is obtained:

$$r_{xoyo} = 1/(\sigma_A^2 + 1) \tag{4}$$

The standard deviation of prediction σ_{pyo} is given by the equation[12]

$$\sigma_{pyo} = \pm\sigma_{yo}\sqrt{1 - r_{xoyo}^2} \tag{5}$$

which, combined with (3) and the foregoing conditions reduces to

$$\sigma_{pyo} = \sqrt{1 + \sigma_A^2}\sqrt{1 - r^2_{xoyo}} \tag{6}$$

The coefficient of alienation is given by the equation[8]

$$a_{xoyo} = \sqrt{1 - r_{xo}^2{}_{yo}} \tag{7}$$

Therefore, for a given value of σ_A, r_{xoyo} can be calculated from equation (4) and σ_{pyo} and a_{xoyo} can then be obtained from equations (6) and (7).

(14) Prediction of True Service Value from Observed Test Value

The correlation coefficient r_{xoy}, the standard deviation of prediction σ_{py}, and the alienation coefficient a_{xoy} can be obtained in terms of the error of measurement σ_A, in a manner similar to that shown in Section 13. Thus, r_{xoy} is given by the equation

$$r_{xoy} = \sqrt{1/(1 + \sigma_A^2)} \tag{8}$$

and

$$\sigma_{py} = a_{xoy} = \sqrt{1 - r^2_{xoy}} \tag{9}$$

[12] G. Udney Yule, *loc. cit.*, p. 177.

IV. Graphical Representation

(15) Prediction of Observed Service Value

The relations obtained in Section 13 were used in preparing the chart shown in Fig. 1, which shows the effect of errors of measurement on the accuracy of prediction of observed service value from observed laboratory value, the errors of measurement being represented by σ_A, measured on the horizontal scale, and the nature and extent of the accuracy of prediction being given by curves showing the values for r_{xoyo}, σ_{pyo}, and a_{xoyo}, measured on the vertical scale.

For $\sigma_A = 0$ (extreme left of chart) it is seen that the correlation between the observed values of X and Y is the same as that between the true values, and the standard deviation of prediction and coefficient of alienation are zero. In other words, when the test is perfectly appropriate and applicable, *i.e.*, $r_{xy} = 1$ and there are no errors of measurement, perfect prediction is secured.

For σ_A not $= 0$, but increasing in value, the observed correlation, r_{xoyo}, decreases rapidly and the standard deviation of prediction, σ_{pyo}, and the alienation coefficient, a_{xoyo}, increase rapidly. When errors of measurement, represented by σ_A, reach the value 1.0, *i.e.*, the value taken for σ_y and σ_x, the observed correlation is only one-half of the true correlation, the standard deviation of prediction is 1.23 and the coefficient of correlation is 0.866. In other words, when repeated determinations of X_o, the observed laboratory test value, and Y_o, the observed service value, on any one brand of brick give values which are distributed as widely as those obtained by determinations of X_o and Y_o for each of a large number of brands, then brands whose value of X_o are identical will have values of Y_o which are distributed about 87% as widely as those of brands chosen at random.

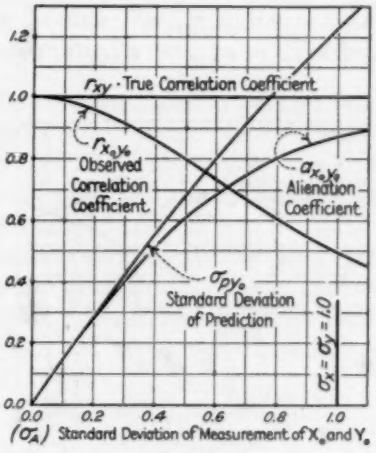

FIG. 1.

(16) Prediction of True Service Value

The relations obtained in Section 14 were used in preparing the chart shown in Fig. 2, which shows the effect of errors of measurement of X_o, represented by σ_A, on the correlation and accuracy of prediction, represented by r_{xoy}, σ_{py}, and a_{xoy}. For this case the standard deviation of prediction σ_{py} is equal to the alienation coefficient a_{xoy}. For $\sigma_A = 0$, the same conditions hold as in Fig. 1. For σ_A greater than zero and

increasing, the observed correlation and the accuracy of prediction decreases although not so rapidly as when predictions of observed service value are required. For $\sigma_A = 1$, the observed correlation coefficient is 0.707 and the coefficient of alienation is also 0.707. Therefore, when repeated measurements of X_o on any one brand give values as widely distributed as those obtained by single measurements performed on a number of brands, *i.e.*, $\sigma_A = \sigma_x$, brands having the same observed laboratory test value will have true service values which are distributed about 70% as widely as those of a number of brands chosen at random. Interpretation of the chart for values of σ_A intermediate between zero and one can be made in the same way.

(17) Extension of Method The simplifying conditions introduced in Section 12 are not of such a nature that they restrict the use of the charts shown in Figs. 1 and 2 to simple cases in which $r_{xy} = 1$ and $\sigma_x = \sigma_y = 1$. For $r_{xy} = 1$, $\sigma_x = \sigma_y = 1$, and $\sigma_{Axo} = \sigma_{Ayo} = \sigma_A$, the curve marked r_{xoyo} in the chart shown in Fig. 1 gives the ratio between r_{xoyo} and r_{xy}, provided σ_A is expressed in terms of σ_x, so that the correct value of r_{xoyo} is readily obtained. The correct alienation coefficient may then be obtained by finding the point corresponding to the correct value of r_{xoyo} on the r_{xoyo} curve and then finding the point directly below this on the a_{xoyo} curve. The standard deviation of prediction can be obtained by multiplying the alienation coefficient by σ_{yo}. The same procedure may be followed with the chart shown in Fig. 2, except that the standard deviation of prediction should be obtained by multiplying the alienation coefficient by σ_y instead of σ_{yo}.

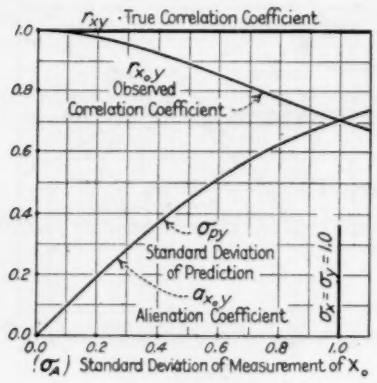

FIG. 2.

(18) Qualitative Conclusions The difficulties which are apt to be encountered when prediction of service value from laboratory test data is attempted with variable materials can now be pointed out. When working with variable materials, such as fire brick, it is very seldom that laboratory tests can be devised for which the correlation between the true laboratory test values and the true service values is unity, and, in addition, it is difficult to reduce errors of sampling and measurement to the point where σ_A is small in comparison with σ_x or σ_y. Both difficulties tend to reduce the accuracy of prediction. The difficulty in devising a test for which r_{xy} is nearly unity is frequently

due to the fact that in the furnace installations in question deterioration may be caused by many factors, the effects of all of which cannot be produced in correct proportions in a laboratory test which can be performed within a reasonable length of time. The difficulties encountered in making test so that σ_A is small in comparison with σ_x or σ_y have been discussed in a previous paper,[13] where it is shown that a very large number of specimens is usually required. The necessity of making σ_A small in comparison with σ_x and σ_y for accurate prediction is shown by the charts in Figs. 1 and 2 and the discussion which accompanies them. It may be concluded, therefore, that for the accurate prediction of service value conditions of (1) design and (2) precision must be satisfied and that the second condition is very important when we are dealing with materials which vary in their properties.

V. Examples

(19) General Examples When a consumer subjects a product to service tests the manufacturer of that product requires a test which will enable him to predict the outcome of the consumer's tests. In this case, prediction of observed service value is required and the conditions discussed in Section 13 and the relations given in Fig. 1 are applicable. If the consumer makes exactly the same test as the manufacturer, then r_{xy} is theoretically equal to unity and the values of r_{xoyo} can be read directly from the chart. If different tests are used, this will not be true and the procedure outlined in Section 17 will have to be followed.

When a consumer uses a laboratory test as a guide in the purchase of materials, he is interested in predicting true service value, and the discussion given in Section 14 and the chart shown in Fig. 2 are applicable. If the laboratory test completely duplicates service conditions, r_{xy} is theoretically equal to one and values of r_{xoy} can be read directly from Fig. 2. If complete duplication is not secured, the values of r_{xoy} obtained from the chart will have to be decreased proportionately.

It is interesting to note that complete duplication of service conditions is often considered a sufficient criterion for the acceptance of a test. At the best, however, this only makes $r_{xy} = 1$ and if σ_A is not small in proportion to σ_x and σ_y, very poor prediction may be obtained, as is shown by the chart in Fig. 2.

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[13] "The Relative Importance of Errors of Sampling and Measurement," *loc. cit.* The symbols σ_v and σ_x of the present paper are equivalent to the symbol σ_T of the previous paper; the symbol σ_A may be considered to have the same meaning in both papers for the case under consideration.

(20) Particular Example Hand-mold or dry-press fire brick are required for a certain part of a furnace. A laboratory test which consists in determining the average transverse strength of four bricks has been proposed. The correlation between true transverse strength and true service value is high, r_{xy} being equal to 0.995. This corresponds to an alienation coefficient, a_{xy}, of 0.10, provided true values can be secured, and would be quite satisfactory as the distribution of service values of brands chosen at random would then be ten times as great as the distribution of service values of brands whose laboratory test values were the same.

An average transverse strength, however, obtained by measurements on four bricks is subject to error, the value of σ_{Axo} for bricks of this kind[14] being about 71 lbs./sq. in. Such averages for a number of brands are not very widely distributed, σ_x being about 212 lbs./sq. in. Therefore, σ_A in terms of σ_x would be 0.335 and the uncorrected value of r_{xoy} obtained from Fig. 2 would be 0.945. The corrected value of r_{xoy} is, therefore, 0.945 x 0.995 = 0.940. This corresponds to an alienation coefficient, a_{xoy}, of 0.34. In other words, if estimates of true service value are based on average transverse strengths obtained from samples of four bricks, the true service values of brands having a common average strength would be distributed about 34% as widely as those of brands chosen at random.

If observed service value is to be predicted, and the errors of measuring service value are subject to approximately the same errors as the laboratory test, then the chart shown in Fig. 1 can be used. In this way, a_{xoyo} is found to be 0.44, which means that the observed service values for a number of brands having a common average strength would be distributed about 44% as widely as the values of brands chosen at random. Errors in determining service value are quite often much larger than those incurred in laboratory tests, so even worse prediction would commonly be secured.

The foregoing example has shown how errors of measurement can increase an alienation coefficient from 0.10 to 0.34 for the prediction of true service value and to 0.44 for the prediction of observed service value, thus decreasing the usefulness of the test.

Summary

The purpose of this paper was to show that accurate prediction of service value from laboratory test data depends not only on the appropriateness and applicability of the test in question but also on certain

[14] The values of σ_{Ax} and σ_x were estimated from data obtained in connection with the investigation of checker brick (see footnote 3). The bricks were broken on edge.

precision conditions which are apt to be quite important in work with materials whose properties are variable, such as fire brick and other ceramic products. The relations between these precision conditions and accuracy of prediction have been derived for cases where true service value and observed service value are to be predicted. These relations have been used in constructing charts by means of which the effect of errors of measurement on accuracy of prediction can be readily determined for cases which commonly arise in ceramic work.

The importance of the precision conditions mentioned in the foregoing has been shown by a discussion of the relations given in the charts and by examples.

Acknowledgment The writer is indebted to C. W. Parmelee, Head of the Department of Ceramic Engineering, University of Illinois, for his interest and help.

COMPARATIVE TESTS ON MONOLITHIC REFRACTORY CEMENTS[1]

By H. N. Clark

ABSTRACT

Samples of the leading monolithic cements on the market were subjected to laboratory tests. The three best cements as determined by the laboratory tests were then subjected to various tests under practical working conditions. This paper covers all the laboratory and practical working tests up to date.

Introduction

Due to the increasing demand for material suitable for repair work, special shapes, baffles, and in many cases for entire linings, more and more attention has been paid to the development of monolithic cements. At present there are many of these cements on the market. Inasmuch as it was obviously impossible to test all of these, only the best known brands were selected. This paper covers the laboratory tests and part of the practical tests on samples of nine cements from seven different manufacturers. For convenience, the cements can be classified as follows.

Group 1 consisting of Cements A, B, E, F, and I can be roughly classified as "plastic" firebrick cements. In trade practice these cements are shipped in wooden barrels or metal one-time containers. All of these cements are wet plastic cements which must be rammed into place.

Group 2 consisting of Cements C, D, G, and H differ from Group 1 in that they are shipped dry in bags, sufficient water being added on the job. These cements are poured into molds or forms, no ramming being required.

The Investigation

The cements were tested in the laboratory for the water content as received, general composition, fineness, drying shrinkage, firing shrinkage, dried and fired strength, softening point, and fire behavior. These lab-

TABLE I

WATER CONTENT AND GENERAL COMPOSITION

Brands	Moisture content received	Lbs. required per 1 cu. ft. dried material	Rational analysis			
			Grog (%)	Bond (%)	Sodium silicate	Organic bond
A	9.87	128	56.73	33.4		
B	11.83	125	60.01	28.18		
C	0.00	105	65.03	34.97		
D	0.00	109	60.41	39.59		
E	11.01	131	54.98	34.01	None	None
F	11.82	130	63.18	36.82		
G	0.00	101	62.95	37.05		
H	0.00	102	67.57	32.43		
I	12.24	122	49.66	38.1		

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Refractories Division.) Received December 21, 1928.

oratory tests were then supplemented by practical tests on the three best cements as determined from above tests. This practical test consisted in placing three large patches averaging 12 square feet in area and 8 inches thick on the fire walls of a 500 H.P. oil-fired Heine boiler and in comparing the results obtained during several months' firing.

From the data in Table I it is evident that there is a wide difference between the two groups, while between the individual members of the groups there is but little variation. The average moisture content of Group 1 was 11.35% with a high content of 12.24% and a low content of 9.87%; the average amount required to ram one cubic foot of material was 127 lbs., the grog content average 56%, and the bond 34%. The cements in Group 2 were even closer to the average, which was 103 lbs. for the amount required to pour a cubic foot of cement, 64% for the amount of grog present, and 36% for the amount of the bond present.

TABLE II

SCREEN ANALYSIS

Brands	Retained on meshes 4*	10	20	40	100	Pan
A	14.0	14.2	15.3	7.6	5.6	Not tested
B	3.4	9.8	23.0	19.0	4.8	" "
C	1.0	8.0	32.0	17.0	8.0	34.0
D	1.0	9.0	35.0	16.0	7.0	32.0
E	11.3	11.4	14.1	8.1	7.1	Not tested
F	10.4	14.0	19.2	8.0	11.5	" "
G	2.0	11.0	31.0	19.0	9.0	28.0
H	2.0	12.0	41.0	22.0	4.0	18.0
I	3.2	10.4	13.8	12.5	10.0	Not tested

* U. S. Standard Screens.

Unfortunately the comparison between the above cements in regard to fineness is of little value as the cements in Group 1 were tested using the wet method and the cements in Group 2 were tested using the dry method. There is little variation between the cements in the same group. That this variation is of little significance is shown by further tests.

Preparation of Samples

The cements were carefully prepared and dried according to the manufacturers' directions, Cements A, B, E, F, and I, being rammed into a 1- by 1- by 10-inch mold, air dried, and dried carefully at 220°F. Cements C, D, G, and H, were

TABLE III

DRIED STRENGTH AND SHRINKAGE

Brands	Linear shrinkage (%)	Modulus of rupture (lbs./sq. in.)	Compressive strength (lbs./sq. in.)
A	1.0	90	750
B	1.6	95	740
C	0.3	850	2500
D	0.0	940	3700
E	1.4	97	805
F	1.0	120	850
G	0.1	225	1540
H	0.1	212	1230
I	1.9	82	470

poured into the mold and allowed to air dry. For compressive strength tests, the mold was subdivided into four parts making the bar actually tested 1 by 1 by $2^1/_2$ inches. The cements were then tested for linear shrinkage, cross-breaking strength, and compressive strength. (See Table III.)

The linear shrinkage is expressed in percentage of plastic length. The cross-breaking strength is expressed as the modulus of rupture in lbs. per sq. in. A shot-testing machine with a five-inch span was used. The compressive strength is expressed in pounds per square inch.

From the data in Table III it is evident that there is a wide difference between the various cements. In the case of the drying shrinkage, the plastic cements group themselves fairly well with an average shrinkage of 4%, and the dry cements all show practically no shrinkage. Contrasted to this is the variation in strength, the modulus of rupture ranging from 82 lbs. in the case of Cement I, to 940 lbs. as shown by Cement D, and the compressive strength ranging from 470 lbs. to 3700 lbs. These figures are of little value, however, unless used in conjunction with the results obtained on the other tests. This is clearly seen in the case of Cement D, which apparently is superior to the other cements, but which in reality is inferior due to its low melting point. (See Table V.)

Fired Strength and Shrinkage

Bars prepared and dried according to the same procedure as those used for Table III were fired in a gas-fired muffle furnace to 2500°F. This temperature was maintained for four hours, at the end of which time all the openings into the furnace were sealed and the furnace allowed to cool. The results of the tests on the fired bars are shown in Table IV.

TABLE IV

Brands	Linear shrinkage (%)	Modulus of rupture (lbs./sq. in.)	Compressive strength (lbs./sq. in.)
A	2.5	1050	3000
B	4.0	1185	3000
C	0.2	3600	*4000
D	0.9	3000	*4000
E	3.5	1200	3100
F	2.5	520	2000
G	0.4	1250	*4000
H	0.4	1120	*4000
I	5.0	2197	3500

* Testing machine would not register above this point.

From Table IV it is evident that the wide difference in shrinkage noticed in Table III still exists when the cements are fired. The results ran from Cement C with a shrinkage of 0.2% to Cement I with 5% shrinkage. This is a very important point indicating that, other things being equal, the cements in Group 2 are superior to the cements in Group 1. It also can be observed from Table III that the cements in Group 2 vary considerably; Cements A and F, having less shrinkage than Cements B, E,

and I. The data obtained on the firing strengths of the cements indicate that with the possible exception of F, the cements are strong enough to withstand the strain and compression caused by the expansion and contraction of the walls in boiler settings and in the various other installations where monolithic linings are commonly used.

Softening Points The cements are then tested for the softening point according to the Standard Method of the AMERICAN CERAMIC SOCIETY. The melting point in terms of Orton pyrometric cones is indicated in Table V together with the cone temperature equivalent.

TABLE V

Brands	Orton cone	Approx. temp. (°F)
A	30–31	3154
B	29	3110
C	23	2894
D	19	2750
E	31	3182
F	29–30	3130
G	27	3038
H	34	3290
I	29–30	3130

The softening point test is probably the most important of the tests carried on. In this case the data obtained show clearly that Cements D and E could not be used for high temperature work. With these two exceptions softening points are amply high, and in the case of one cement the softening point is considerably higher than that of a first class fire brick. It was decided that this was undoubtedly due to a high alumina content. In an effort to check this assumption a chemical analysis of this cement was made. The results indicated that the alumina content of this cement was approximately 20% higher than that of Cement E, with the next highest softening point.

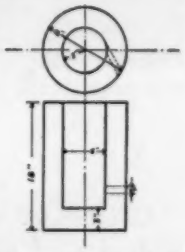

FIG. 1.—Gas-fired test furnace.

Small Furnace Test

Previous tests having been made on comparatively small samples, it was decided to run tests on larger masses of materials. For this purpose nine small furnaces (See Fig. 1) were constructed, each being rammed or poured from a different brand. The mold consisted of an 18-inch section of 12-inch pipe, a 15-inch section of 6-inch pipe, and a $3\frac{1}{2}$-inch piece of $1\frac{1}{2}$-inch pipe. The walls and bottoms of the furnaces were therefore 3 inches thick. The cements from Group 1 were rammed into place with a heavy piece of wood while the cements in Group 2 were poured. The inner forms were removed at the end of twenty-four hours' drying time and a slow fire started. A Maxon Premix gas burner was used throughout the test. Orton cones were used to indicate temperatures.

Procedure The temperature in the furnace was gradually raised, close watch being made of the firing behavior of the cements, until a temperature of 2800°F was reached. This temperature was maintained for an hour. The gas was then turned off, and the air left on until the furnace was cool. The furnace was then heated rapidly to 3000°F and cooled as above, this procedure being followed three times in order to obtain a spalling effect. Results of tests are shown in Table VI.

TABLE VI

FIRING BEHAVIOR

Brands	220°F	2000°F	2800°F	3000°F (3 heats)
A	Shrinkage Surface cracks	Surface cracks	Cracked through wall	Cracking increased, drying cracks opened
B	Shrinkage Slight cracking	Cracks opened	" " "	Badly cracked
C	No shrinkage No cracking	Hair cracks	Surface fusion	Fused (1st heat)
D	No shrinkage No cracking	" "	Fused and eroded	
E	Shrinkage Slight cracking	Slight cracking	Cracked through wall	Many small cracks, drying cracks opened
F	Surface cracks	" "	" " "	Cracked badly with slight spalling
G	No shrinkage No cracking	No cracking	Hair cracks	Surface cracks
H	No shrinkage No cracking	" "	" "	" "
I	Shrinkage Small cracks	Cracks opened	Badly cracked	Cracked and spalled

After a careful study of the results obtained in this test together with the other laboratory tests, Brands H, G, and A were selected as indicating superiority. It was found, however, that the price of Cement H was considerably in excess of the other brands and for this reason Cement E was substituted in the practical tests.

Large Furnace Test

As indicated previously, the three cements were installed in the fire walls of a 500 H.P. oil-fired Heine boiler. Cement G was poured in back of a wooden form braced against the side of the brick wall. Upon removal of the form at the end of twenty-four hours the cement was fairly hard and became stronger as the surface dried out. No cracking was observed.

Cement A was rammed into place in a patch immediately above Cement G, and Cement E was rammed into place on the opposite side wall. Heavy wooden mallets were used for ramming. Both cements became hard on the surface upon drying, but in both cases the cements cracked badly.

The Cement G patch was approximately 5 by 3 feet and 8 inches thick; Cement A patch was 5 by $1^1/_2$ feet and from 2 to 8 inches thick; Cement E patch was 5 by 4 feet and 8 inches thick. (See Fig. 2.)

Results At the end of a month's firing, Cement G was still in place showing no signs of fusion, cracking, or spalling. Cement E had pulled entirely away from the wall showing a crack about two inches wide between the wall and the patch as well as many smaller cracks. This patch must be replaced as soon as the boiler can be taken "off line." Cement A was cracked similarly, but the largest crack was only about $1^1/_2$ inches wide. A portion of the top of the patch was broken off and many small cracks could be seen in the body of the material. No sign of fusion was observed in this cement.

FIG. 2.

Conclusion

Eliminating Cement H because of its much higher cost, it is evident that of the remaining cements, Cement G is far superior to the other brands tested. Very little difference is shown between the next best Cement E, and the other cements in the same classification. This conclusion is by no means final, and other comparative tests are being made under practical working conditions in order to further substantiate these findings.

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USE OF PULVERIZED COAL AS A FUEL FOR PERIODIC KILNS[1]

By D. J. Watson[2]

ABSTRACT

A research problem on the control of the temperature, using pulverized coal as a fuel for intermittent kilns. The paper consists of a description of the operation and design of a fire box with a hot-spot combustion chamber for the ignition of the fuel during the water-smoking period, and first part of the oxidation period.

Introduction

In the past few years pulverized coal has proved to be economical under boilers and also as a fuel for continuous kilns. Unsuccessful attempts have been made in the past to burn this fuel in periodic kilns, the difficulty being the inability to keep the temperature down during the water-smoking period. Powdered coal requires a red or greater heat for combustion. To maintain this heat for any length of time in the fire box soon brings the entire kiln much above the water-smoking temperature.

Kiln Used in Tests

A kiln designed by D. A. Moulton was converted into a fire box for the purpose of this experiment[3] (see Fig. 1). A combustion compartment 18 inches deep was built into the fore part of the kiln. The remaining 12 inches in the rear served as a mixing chamber. The floor of the kiln was built up $2^1/_2$ inches to form a sump for the ash.

Combustion Chamber The refractory roof of the combustion chamber was supported by two 2-inch thick rectangular tile, protecting the combustion chamber plates from being cooled by the cold air passing along their sides. There was a space of $2^1/_2$ inches at the side of these for the passage of the cold air into the mixing chamber.

The sides of the combustion chamber consisted of iron gates, hinged to swing horizontally. When opened to their fullest extent they lie tight along the baffle walls. When in a closed position the gates form a wedge pointing toward the rear of the fire box. (See Fig. 1.) The only escape for the gases of combustion while the gates are closed is at the top and bottom of the gates.

Coal Feeder The feeding apparatus shown in Figs. 1, 2, and 3, consisted of a small hopper which carried a supply of coal sufficient for an eighteen-hour period at the lowest possible rate of feed.

The coal is carried into the primary air line by a one-inch screw inclosed

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[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Heavy Clay Products Division.) Received August 10, 1928.

[2] Undergraduate student, Iowa State College.

[3] *Jour. Amer. Ceram. Soc.*, **5** [10], 713 (1922).

in a pipe. The air enters several inches behind the discharge end of the screw, preventing the air from blowing back into the hopper. The screw mixes the coal and air well before they enter the burner.

The screw is operated with a small motor through a reduction gear and two cones, as shown in Figs. 2 and 3. The cones give the necessary speed variation of the screw. Within the hopper are two small jets of air to agitate the coal and keep it flowing freely to the screw. This device is belt driven.

A much more satisfactory method would have been to feed the coal to the burner in some such manner as described by Frank M. Hartford,[4] that of delivering the fuel direct by means of an exhaust fan.

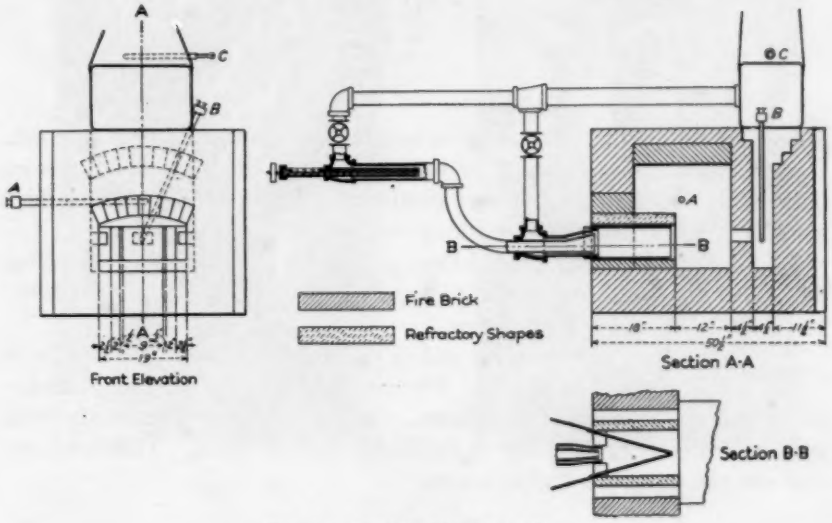

FIG. 1.—Rebuilt Moulton kiln.

Air Control The air is delivered to the preheater through a four-inch line from a low-pressure blower. The primary air supply is controlled by a valve ahead of the mixing tube, while the secondary air line has a valve just in front of the burner. The burner consists of two separate sleeves, one within the other, and spreading into a fan at the outer end. The primary air and coal follow through the inner sleeve. The secondary air is delivered through the outer sleeve.

The Coal Used The coal used throughout the experiment was from the Orilla Mine of the Great Western Coal Company, Valley Junction, Iowa. The coal was sized to pass over a $^1/_8$- and through a $^1/_4$-inch screen before washing. A Butchart concentrator table

[4] *Jour. Amer. Ceram. Soc.*, 9 [10], 684–89 (1926).

and a pulsating jig were used to remove from the coal as much sulphur and ash as possible.

FUEL ANALYSIS
Moisture Free Basis

	Refuse through 1/4 on 1/8	Washed through 1/4 on 1/8	Fed through 1/4 on 1/8
Volatile matter (%)		46.86	42.88
Fixed carbon (%)		45.12	42.39
Ash (%)	47.62	8.02	14.73
Sulphur (%)	19.39	4.74	6.81
B.t.u. per lb.		13,130	12,373

WASHING RESULTS

	Through 1/4 on 1/8	
	Weight	%
Feed	296.5 lbs.	
Washed coal	234.5 "	79.1
Middlings	20.0 "	6.7
Refuse	34.0 "	11.5
Dust loss	8.0 "	2.7
		100.0

Low-grade fuel can be washed, as is shown, to remove sulphur and ash, thereby making it adaptable to ceramic use. Coal for other purposes is being washed now at a cost of twenty to thirty-five cents a ton which would not be prohibitive in washing coal for ceramic use.

Following the washing, the coal was pulverized in a Hardinge classifying mill and separated with an air classifier. About 85% of the pulverized coal would pass a 200-mesh sieve.

Pyrometers Two pyrometers and a thermometer were placed, as is shown in Fig. 1, Pyrometer A in the mixing chamber above the direct path of the flame, and Pyrometer B behind the flash wall, but directly in the path of the flame and hot gases. The thermometer was placed above the preheater.

Test Procedure

The burner was started by first closing the baffle gates and placing a small piece of saturated waste before the burner. The fan and screw were then started and the waste set afire. The primary air was then opened slightly, only enough allowed to pass to carry the coal. The waste soon burned out, but red coke formed at the point of the combustion chamber which kept the burner lighted after the waste had burned out. A period of fifteen to twenty minutes brought the baffle plates to a red heat, after which all traces of coke disappeared. Until temperatures much greater than those desired for water-smoking are needed, the secondary air is not necessary as additional air for combustion.

Alteration in Design As the fire box was first constructed, there were no cold air ducts leading into the mixing chamber. The adjustable sides of the combustion chamber were heavy re-

fractory tile (about 2 inches thick). Four hours of heavy firing were required to bring the refractory tile to a red heat, and at the end of the period the flue-gas temperatures were so high (500°F) that any attempt to continue would have been useless. Poor combustion during these four hours was also experienced.

The refractory baffle plates were replaced by reinforced sheet-iron gates. The steel plates reached a white heat and all trace of coke had been removed from the combustion chamber within fifteen minutes.

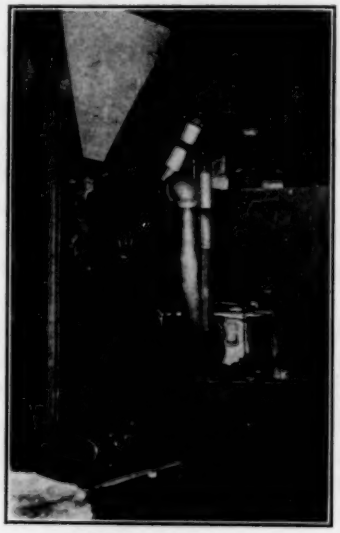

FIG. 2.

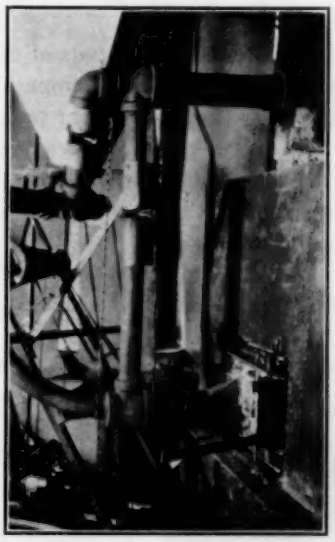

FIG. 3.

Temperatures Attained

The temperatures at A, B, and C were recorded every fifteen minutes. On first starting, the temperatures ran slightly higher than the average until the burner and air became warm and the screw speed could be regulated. During a firing of eight hours the temperatures recorded were as follows:

	Max. temp. (°F)	Min. temp. (°F)	Av. temp. (°F)
Pyrometer A	935	810	840
" B	655	595	630
Thermometer C	345	300	315

Second Alteration in Design

These temperatures were still too high for the desired purpose so the fire box was reconstructed and cold-air ducts were built one along each side of the combustion compartment.

It was found that by protecting the baffle plates from cold drafts by means of refractory tile, the plates could be kept at a higher temperature with less coal consumed, and a lower temperature maintained in the mixing chamber.

Temperatures in Third Test Firing

During a period of twelve hours, the recorded temperatures were as follows:

	Max. temp. (°F)	Min. temp. (°F)	Av. temp. (°F)
Pyrometer A	730	640	660
" B	340	480	400
Thermometer C	255	240	248

Approximately eight pounds of coal were consumed per hour while operating at the lowest possible temperature.

Following the twelve-hour period, the speed of the screw was increased and the baffle gates gradually opened as the fire-box temperature increased. Although both baffle gates were removable, only one was removed when the temperature reached a point high enough so that they were no longer necessary.

The object in not removing the one gate was to determine the effect of the hot gases upon the metal.

During the remaining two and one-half hours of this firing, the temperature was brought to 2200°F, a temperature gradient of 720°F per hour.

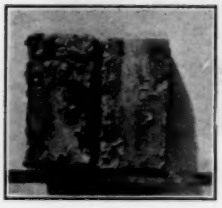

FIG. 4.

Slagging Action

The baffle gate which was removed was warped slightly, but indicated little damage from oxidation. The plate not removed was more than half corroded away. This, of course, only indicates the necessity of removing the gates as soon as complete combustion can be had without their aid. Figure 4 shows the slagging action of the coal ash on two No. 1 fire brick lying a few inches in front of the burner directly in the path of the flame on the floor of the fire box.

The unprotected pyrometer tube, B, was damaged due to the fusion of the ash upon it, causing a drip at the end.

Completeness of Combustion

Good combustion was maintained throughout the last firing, there being no smoke whatever following the first fifteen to thirty minutes.

Conclusions

It has been shown that pulverized fuel can easily be burned in intermittent kilns by constructing a fire box, the size of which can be varied at will. The only necessary requirement is that a small hot spot for combustion, from which the hot gases can escape into the kiln, be maintained during the water-smoking period.

Suggestions Figure 5 is the design of the fire box suggested for commercial practice. It has been so designed that it can be built into the average fire box of a round downdraft kiln without changing materially the original fire-box design. This fire box is designed so that the flame will not beat directly upon the refractory walls.

Three-eighths to one-half inch cast-iron baffle gates are suggested. These gates can be opened or closed as well as removed without disturbing the operation of the burner.

Sheet-iron doors are shown hung at each side of the box controlling the volume of free air entering the mixing chamber.

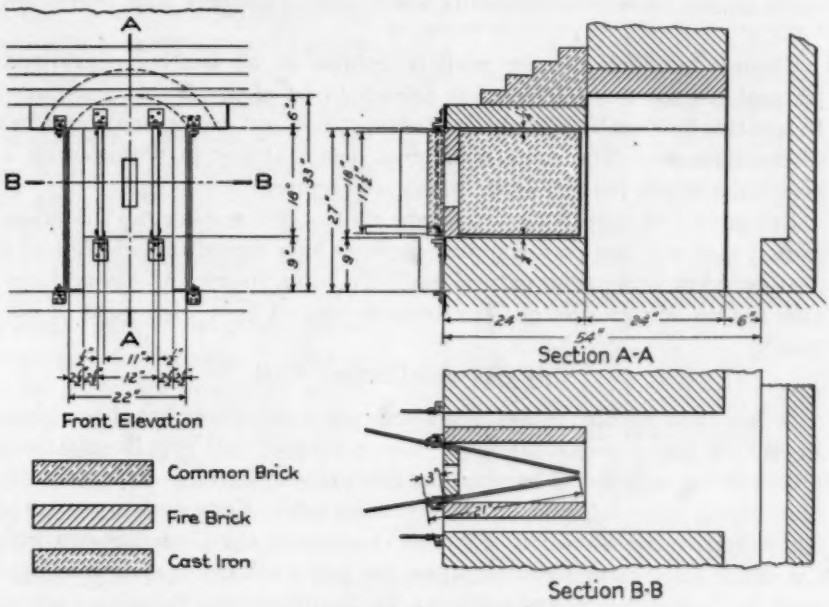

FIG. 5.—Fire-box design.

The design of this fire box has not been greatly changed from that used in these experiments with the exception of a larger ash sump, a larger capacity for cold air, cast-iron gates, and a more roomy construction throughout.

This apparatus has not been used on a commercial kiln, but the experimental results were so conclusive that there is little question but what it would be successful and economical.

Acknowledgments The author wishes to acknowledge the willing help and coöperation of W. H. Meeker, Mechanical Engineering Department, who opened the mechanical shops to the building of the equipment, and Paul E. Cox, who suggested and made possible the carrying of the work to conclusion.

STABILITY AND PROGRESS OF THE PUBLIC UTILITY FUEL SERVICE[1]

By E. L. Gates

ABSTRACT

Because ceramic products require accurate control in all heating operations, natural gas has acquired a high rating as a fuel, but because of difficulties encountered such as exhaustion of supply, distant markets, etc., producer gas is more popular. City gas is available in all urban localities and therefore broadens the selection of location for any industry. The question of price of the city gas as compared with natural gas is dealt with and it is pointed out that the increase in recovery of by-products and efficiency of manufacture, together with a steady decline of price of the utility fuel service since 1923, tends to lessen the difference in price between city and natural gas. Examples are cited where city gas is used for enamel smelting and brick firing successfully.

Ceramic products require positive control in all heating operations. Natural gas for this purpose has proved to be of invaluable assistance. In fact this fuel has been the basis of competitive survival in many branches of the industry. The same quality of dependability in performance is demanded of any heating agent which is to replace natural gas.

Exhaustion of supply, governmental control, inaccessible raw materials, distant markets, and poor shipping facilities have forced the selection of a heating agent other than natural gas. To duplicate natural gas performance the use of producer gas has been developed to a high point of efficiency.

City Gas as a Ceramic Fuel

It has been within recent years only that attention has been given to city gas as an industrial fuel. This source of fuel supply materially broadens the selection of location for any industry because it is available in nearly all urban localities. The prevailing price of city gas has prevented any extensive consideration of its use throughout the United States with the exception of those localities where the larger utility organizations have made industrial studies and surveys. In these instances there has been an adjustment of price downward, resulting in the sale of considerable quantities of gas for ceramic fuel requirements.

The consistent reduction in the price of gas compared with the trend of prices of other commodities is shown in curves in Fig. 1, which represent increase and decrease in percentage covering the period from 1914 to 1928. Attention is especially directed to the comparison of the prices of fuels. The striking feature is that while the price of the utility fuel service follows close to a straight line, it indicates a decided drop since the year 1923.

Improvements in efficient manufacture, coupled with increased recovery

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Refractories Division.) Received December 17, 1928.

of by-products, have reduced prices irrespective of the marked increase in cost of labor and raw products. Further economies in manufacturing are looked for, resulting in increased profits with corresponding reduction in price to the consumer.

The volume of gas used has increased until, during the year 1928, there was purchased by ceramic manufacturers in the city of Chicago more than 130 million cubic feet of gas. Add 300 million cubic feet purchased from the Public Service Company of Northern Illinois and the total purchased is found to be well in excess of 400 million cubic feet. This represents a yearly expenditure within a radius of 200 miles of Chicago, approximating $280,000 and surveys reveal that this is only one-quarter of the possibilities for utility gas service to ceramic industries in the Chicago district.

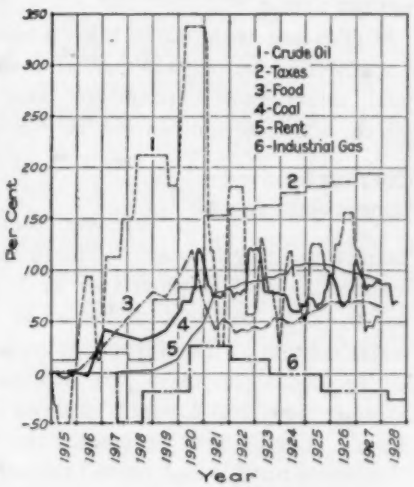

FIG. 1.

The benefits of collecting large quantities of solid or crude fuel under one controlling agency are not difficult to visualize. Instead of shipping coal or oil in small quantities to a thousand different points of use, it is shipped direct from the mine to the utility, where it is converted into gas. Valuable by-products are recovered which would otherwise be wasted. The gas is delivered in the form of a refined fuel for use where heat is needed. In this manner the responsibility of fuel, transportation, handling, storage, and purchase are eliminated from the obligations of the manufacturer. These functions are all performed for him by the utility. The industrial use of fuel gas has been developed to a high point of efficiency in the ceramic industry as well as in the steel industry. They deserve particular credit for the competent manner in which they have accomplished this development.

The constant quality, high calorific value, and low cost of natural gas made possible its use without particular attention being given to combustion efficiency. The development of high combustion efficiency in the use of producer gas as well as other fuel gases of comparatively low calorific value was an absolute necessity in its successful substitution for natural gas. High efficiency of furnace construction and application of accurate combustion principles began with the use of these gases.

The use of city gas for ceramic firing has been delayed by its price.

Those utilities, however, which have shown any inclination to meet these fuel price conditions have in return received wholesome coöperation from the ceramic industry. Consequently, a considerable number of installations have been made throughout the United States.

A complete conversion from crude fuel to gas has just been made in a large plant located in Chicago. The windows in this plant had not been washed in at least ten years. After the windows were cleaned, and a gas system installed for all heat requirements, they operated upon reasonably bright days with daylight only. Cleaning up and painting the plant white has had a very marked effect upon the workman. In addition to the agreeable surroundings established, there is a marked increase of production per man.

Muffles are required in kilns where impure fuels are used. The heat is transferred through a wall at considerable loss of efficiency and with much unnecessary expense for both fuel and refractory repairs. With gas the old-time muffles can be removed from the kilns.

City Gas for Enamel Smelting

The smelting of frit with city gas is now being carried on very satisfactorily. A five-day operating test was conducted upon a No. 4 U. S. Rotary Enamel Smelting Furnace. The burner was supplied by the U. S. Smelting Furnace Co. and employed air at 1-lb. pressure from a Spencer turbine blower. The gas was delivered at the furnace under 6-inch pressure (water column). The furnace was operated five days per week, from Monday to Friday, inclusive. It was heated to about 1500°F each morning before being charged, which required about 30 minutes and 2300 cubic feet of gas. As each heat progressed the furnace was rotated about 15° every 15 minutes until it had moved through an angle of 90°, at which time the charge was completely smelted. Then the furnace was rotated continuously for a time long enough to allow the mass to become thoroughly homogeneous. The charge was then poured into a pan of cold water at a temperature of about 2800°F and the furnace reloaded for the next heat. The weight of the charges varied from 625 to 850 pounds, but averaged about 750 pounds. The average firing time per heat varied from 2 to

Frit no.	Total lbs. charged	Total lbs. output	Total gas consumption	Cu. ft. gas/lb. charged	Loss (%)
420	60,614	55,096	621,300	10.25	9.12
242	2,927	2,440	27,300	9.32	16.62
424	10,800	9,491	118,300	10.95	12.11
425	26,497	24,867	414,900	15.65	6.15
426	18,224	16,909	239,600	13.13	7.21
1314	4,245	4,011	55,600	13.1	5.52
388	5,359	5,172	56,000	10.45	3.49
Total or average	128,666	117,986	1,533,000	11.9	8.31

Price of gas—60¢ per MCF

$$\frac{1.533 \times 0.60}{117.986} = \$0.77 \text{ per } 100 \text{ lbs.}$$

$2^3/_4$ hours, and the number of heats per day from 3 to 4, depending on the kind of frit being smelted.

The period during which the following data were collected extended from October 11 to December 28, 1928.

City Gas for Brick Firing

During the past three or four years considerable development work has been done in the application of gas for firing brick. The first seven arches on a scove kiln were started with intervals of three to six hours, and from that point, on a new arch, was put under fire every eight hours. As the firing progressed, the burners on the arches on which firing had been completed were removed, the burner opening bricked up, and the burners placed on the next arch on which firing was to be started. With this procedure, five to seven arches were under fire at one time.

The kiln fired was of the scove or updraft type, 35 feet wide, 231 feet long. It contained 50 arches, each composed of 36,500 green machine-stacked brick. The brick before being stacked in the kiln were dried in ovens heated with the aid of waste heat from steam boilers and kilns. Each arch was fired with two National Machine Triplex burners, one placed in each end of the combustion chamber. The combustion chamber consisted of a tunnel about 14 inches wide, 20 inches high, running the full width of the kiln. All burners were operated on a maximum gas pressure of three pounds per square inch and used neither auxiliary air nor steam to aid combustion.

TEST DATA

Duration of test	396 hrs.
No. of arches fired (one kiln)	50
No. of brick per arch	36,500
Total no. brick fired	1,825,000
Average time each arch under fire	45.7 hrs.
Total gas consumption	5,735,600 cu. ft.
Maximum hourly gas consumption	20,400 cu. ft.
Average hourly gas consumption	14,500 cu. ft.
Gas consumption per 1000 brick	3,140 cu. ft.

In another yard the arches in the kiln are fired progressively. Three arches at one end of the kiln are started simultaneously and then after six hours the next adjacent arch is started and so on along the kiln until the last three arches are reached, firing on which is again begun simultaneously. This cycle on a 15-arch kiln requires about 90 hours. The time each arch is under fire varies from 22 to 34 hours, depending on weather conditions and moisture content in the brick.

The kilns are of the scove or updraft type, 35 feet wide, 14 feet high, and varying in length from 40 to 120 feet. The number of arches or tunnels in a kiln varies from 10 to 30, being built in the bottom of the kiln and running its full width. They comprise the firing or combustion chamber, one burner being placed at each end of the arch. The burner consists of

a $1^1/_4$- by 6-inch nipple on the end of which is a $1^1/_4$-inch atmospheric brass mixer. Gas is supplied to the burners at 13 pounds pressure by a displacement compressor. The green brick, before being hand-stacked in the kiln, are air-dried by being allowed to remain in the open for a period varying from two to six weeks. The brick are of the common type, measuring 2 by 4 by 8 inches, a total of 39,000 being stacked per arch.

The figures following were obtained over two periods, one extending from May to December, 1924, inclusive, and the other from May to November, 1925, inclusive.

Duration of test	8 months	7 months
Total no. of arches fired	458	410
Average firing temperature	1800°F	1800°F
Average no. brick per arch	39,000	39,000
Total no. brick fired	17,786,200	15,990,000
Total gas consumption	36,520,000	36,194,400
Cu. ft. gas per 1000 brick	2,050	2,260
B.t.u. of gas	535	535
Cost per 1000 brick	$1.02	$1.13

Utilities are prepared to deliver a superior fuel at a price which will establish economies. There are many engineering and contracting organizations ready to supply equipment designed for the use of gas. Throughout the Chicago districts the utilities maintain competent industrial engineering organizations which coöperate to the fullest extent in the selection, design, construction, and operation of all processing equipment involving heat. In addition, modern physical laboratories are maintained under the direction of efficient technical staffs, to aid users of heat in industry.

The growth of the use of gas has been phenomenal. Barely ten years ago manufacturers knew practically nothing about using city gas in their plants. Today nearly 30% of all manufactured gas and 75% of all natural gas is used in industry. Millions of dollars are spent annually for the purchase of heating equipment designed chiefly to burn gas. Industrial management throughout the country has been quick to grasp the fact that of all the fuels, gas adapts itself to the use of automatic devices in a manner far superior to any of the other fuels. The essence of these statements is significant and warrants the consideration of every plant manager who is responsible for minimum manufacturing costs.

The Peoples Gas, Light and Coke Co.
Chicago, Ill.

NOTES ON DRY-PAN AND WET-PAN OPERATION[1]

By J. M. Gallaher

ABSTRACT

The article is a discussion of the following points: (1) improvement in dry and wet pans with the introduction of high capacity heavy-duty units to replace several units and requiring less power and maintenance; (2) engineering cost data with respect to economical operating speeds, results of which were obtained from an actual installation calculated on an average power rate; (3) relation of rotation rate to capacity, considering the effect of the speed of rotation on the efficiency of the emptying device; (4) the optimum size for economical operations at various capacities, an intelligent answer to which cannot be given without a thorough study of the many factors involved, some of which are discussed in the article.

Introduction

The following points will be discussed in this paper: (1) improvement in dry and wet pans, (2) engineering cost data with respect to most economical operating speeds, (3) relation of rate of rotation to capacity, (4) the optimum size for most economical operation at various capacities, and (5) the best size of pan to use for grinding various types of clays.

With given raw materials minimum production costs depend on capacity production and efficient machinery and labor. The plant manager can control the production and labor if he has efficient machinery. He may be forced by conditions entirely beyond his control to operate his plant with inefficient machinery hoping that at prevailing prices in the industry his costs will permit him to market his product at a reasonable profit. On the other hand, he may be able to have a careful study made of his plant layout, replace inefficient machinery, and reap a high percentage of return on invested capital.

Improvement in Pans

The development of improvements in pans is of primary interest. The outstanding feature in this field in the past two years is the introduction of high capacity heavy-duty units which have in many instances replaced several units and which, due to improvements in design, require less power and maintenance.

Twenty Timken tapered roller bearings are incorporated in the design of the largest dry pan in the Maximuller plant. The gearing is entirely inclosed and runs in a bath of oil. As a result of these and other points of design, power tests on this machine, which has a total weight of 95,000 pounds and a crushing weight of 30,000 pounds, show that it requires little more power than our standard 9-ft. dry pan which has a total weight of 54,000 pounds and a crushing weight of 18,000 pounds.

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Refractories Division.) Received December 24, 1928.

A heavy-duty underdriven wet pan is also equipped with Timken bearings and the drive is through a steel worm and bronze worm wheel fully inclosed and running in oil.

Bearings of any type will sometimes fail in service and be condemned by the machine owner. Occasionally the fault is in the bearing or in the design of its application, but more often it can be traced to faulty lubrication.

The reduction in wear and vibration of gearing running in an oil bath will be apparent, particularly in a dry pan.

Operation Economy Results obtained from an actual installation calculated on an average power rate are:

PLANT A	H.P.	PLANT B	H.P.
4 dry pans at 40 H.P.	160	1 Maximuller	75
4 elevators at 10 H.P.	40	1 " elevator	25
Total	200	Total	100
200 H. P. = 150 kw.		100 H. P. = 75 kw.	
10 hrs. per day = 1500 kw. hr. a day		10 hrs. a day = 750 kw. hr. a day	
300 days a year = 450,000 kw. hr.		300 days a year = 225,000 kw. hr.	
450,000 kw. hr. at $1^1/_2$¢ = $6750.00		225,000 kw. hr. at $1^1/_2$¢ = $3375.00	

Difference in power cost a year for grinding = $3375.00.
$3375.00 = 6% interest on $56,250.00

Note that this does not take into account the saving in labor cost and in the maintenance cost of one machine as compared to four.

Pan Speeds There are few cost data on operating speeds, or little accurate information on the relation of rate of rotation to capacity. After many years' experience it is believed that rim speeds of from 900 to 950 feet per minute give best results for pans. Speeds of 30 r.p.m. for the Maximuller, 32 r.p.m. for the 9-ft. dry pan, 33 r.p.m. for the 8-ft. wet pan are recommended.

In determining the speed of a wet pan, consideration must be given to its effect on the efficiency of the emptying device. The best emptying speed may depend in some instances on the nature of the material.

Excessive dry pan speeds reduce the production of fines. The charge is not retained on the grinding circle long enough to be ground. If the discharge openings are small the high percentage of coarse particles prevents escape of the fines. With large discharge openings an excessive circulating load of tailings is built up. These statements are not merely theoretical deductions. Actual results from reducing speeds of dry pans originally installed to operate at speeds as high as 50 r.p.m. have shown material increases in tonnage of fines. With reduced speeds there is a corresponding saving in wear and maintenance cost.

Optimum Pan Size The questions of optimum size of pan for most economical operation at various capacities and the best size for various types of raw material are of special interest and an

intelligent answer cannot be given without a thorough study of the many factors involved. Some of these are as follows:

(1) What hourly or daily tonnage do you require? Do you anticipate a future increase in this tonnage requirement?

(2) An examination of samples of the raw material.

(3) To what fineness do you expect to grind and what relative proportion of fines should a screen test of the product show?

(4) Must the grinding process be continuous, with an even flow of material direct to brickmaking machinery of definite capacity, or can the grinding unit be operated independently with a discharge of the product into adequate storage bins?

(5) Will a crusher be installed ahead of the pan or what is the maximum and average size of the units making up the charge?

(6) What is the moisture content of the material? Is it subject to considerable variation?

(7) What method of feeding raw material; conveying or elevating and screening the product will be employed? Will the capacity of such subsidiary equipment be based on the recommendations of the manufacturer of the pan, or is it already fixed?

Wet pans are essentially batch grinders and the questions on which an intelligent decision as to size must be based are not generally difficult to answer.

Dry pans are continuous grinders and should be operated as such. A dry pan which, because of inefficient feeding or production handling equipment, is running empty, a portion of its operating time cannot be expected to do what the manufacturer intended it to do and it is consuming power all the time. The same is true if it is being recharged with tailings, a large portion of which should have been taken out by the screens. The maintenance cost on a dry pan is also much higher when running empty.

The capacity of machines of different sizes and design can only be determined from actual installations and the difficulty of doing this is well illustrated as follows:

	Grinding units	
Analysis of fines	A (%)	B (%)
Finer than 10-mesh	100.0	100.0
" " 12 "	99.9	99.5
" " 16 "	98.6	92.1
" " 20 "	92.6	77.1
" " 30 "	73.3	64.4
" " 40 "	63.4	44.1
" " 60 "	42.1	22.1

29% of tailings returned to machine "A" passed through a 12-mesh test screen.
14% of tailings returned to machine "B" passed through a 12-mesh test screen.

This shows results from an actual installation of two heavy-duty grinding units operating side by side on the same raw material.

For a 15-day period the average production of screened product per hour from machine "A" was 17.3 tons and from machine "B," 10.8 tons. This shows a decided advantage for machine "A" in tonnage, but in addition it is grinding much finer. About 63% of the product from machine "A" is finer than 40-mesh, whereas only 44% of the product from machine "B" will pass this test.

Also the efficiency of the screens at machine "A" is lower than in the case of machine "B," due to the fact that not enough screens were installed at "A" to handle the larger tonnage. If measures were adopted to equalize more nearly the relative proportion of fines and the screen efficiency it might safely be assumed that the advantage in favor of machine "A" would be much greater.

The fallacy of judging the capacity of a pan by its rim diameter should be emphasized. The crushing weight and grinding area are the important factors.

CLEARFIELD MACHINE COMPANY
CLEARFIELD, PA.

THE EFFECT OF CORES IN BRICK DIES ON POWER CONSUMPTION[1]

By D. P. Ogden

ABSTRACT

Recording wattmeter determinations of power, moisture content and production rates were secured on an individually motor driven auger machine for each of two standard brick dies, with and without cores. Variation in these factors was recorded. Use of cores causes a great increase in power consumption per thousand brick. Moisture content variation ranged from 17.7 to 20.1%.

The object of experimental work herewith reported was to determine accurately the effect of putting three round $1^1/_4$-inch diameter cores in each of the two kinds of standard brick dies regularly used in production at the plant of the Streator (Ill.) Brick Company. As a check, moisture content was also determined simultaneously with each of three conditions

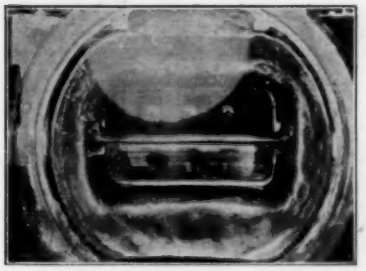

Fig. 1.—Entrance end of 4- by $8^1/_2$-inch Freese standard brick die with core bridge for three $1^1/_4$-inch diameter round cores.

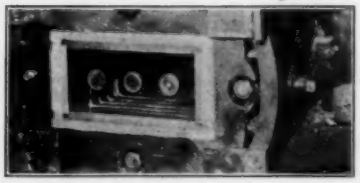

Fig. 2.—Mouth end of 4- by $8^1/_2$-inch Freese standard brick die with three $1^1/_4$-inch diameter round cores.

of the brick column issuing from the brick machine by taking a suitable slab from one of the bricks at the instant that the column seemed to be of the desired hardness or moisture content. The corresponding speed of the column was secured at the time each such sample slab was taken by counting the number of cuts per minute made by the brick machine cutter.

The Chambers die used consisted of two solid castings, which when assembled, constituted a gradually tapering funnel terminating in a rectangular mouth measuring 4 by $8^1/_2$ inches. About three-fourths of the way from the mouth to the back of the die a lubricating groove or recess extends entirely around the cross-section such that lubricating oil

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Heavy Clay Products Division.)

can be applied under pressure between the outside surface of the clay and the inside surface of the die.

The Freese die is built up of a group of rectangular frame-shaped castings each fitting one into the next and mounted inside of suitable outer box castings such that the inside surface is also funnel shaped and terminates in a rectangular mouth 4 by $8^1/_2$ inches. Lubrication reaches the column in the last half of the Freese die by flowing in between these frame castings. Due to the shape of the die and its general characteristics it is not necessary to apply this oil under pressure.

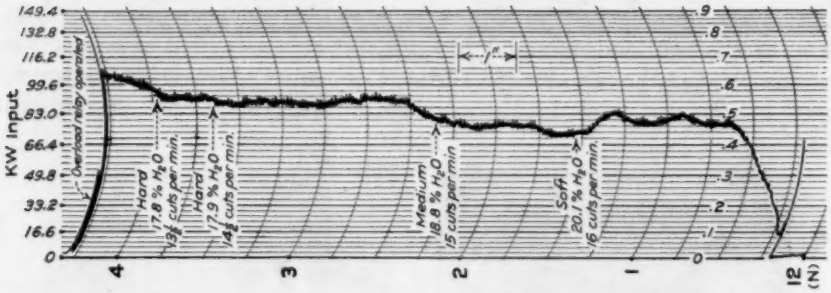

FIG. 3.—Freese die with cores; kw. input to 75-H.P. G. E. motor at Streator (Ill.) Brick Co.; chart 1 in./min.

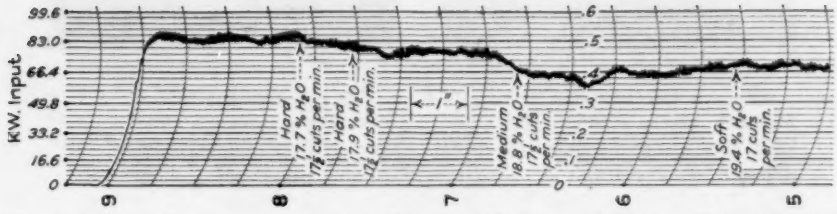

FIG. 4.—Freese die, only; kw. input to 75-H.P. G. E. motor at Streator (Ill.) Brick Co.; chart speed 1 in./min.

The chief difference between these two dies is that the Chambers die is tapered gradually from the entrance end to the beginning of the last four inches which is rectangular and essentially of uniform cross-section to the mouth of the die, whereas the Freese die has its cross-section decreased very abruptly in the entrance end to a rectangular tapering section extending from half way through the die to the front. The front to back length of the Chambers die is three inches greater than the Freese die and practically all of this additional length is taken up in the more gradual taper at the entrance of the die.

The cores were supported in the accompanying photographs on single bar core bridges inserted in slots cut in the entrance of the die such that

it was easily possible to remove the cores and to get control data on identically the same dies without the cores.

Four runs were made as follows:

Run 803-100 (Chambers die with cores)
Run 803-200 (Chambers die only)
Run 803-300 (Freese die with cores)
Run 803-400 (Freese die only)

In each run with the auger machine running continuously the moisture content of the column was changed from very soft to medium and then to hard, in some cases until the overload relay of the motor control tripped out. The quantity of shale fed to the pug mill was left constant except that it was necessary to shut off the disk feeder entirely whenever the

FIG. 5.—Entrance end of 4- by $8^1/_2$-inch Chambers standard brick die with core bridge for three $1^1/_4$-inch diameter round cores.

FIG. 6.—Mouth end of 4- by $8^1/_2$-inch Chambers standard brick die with three $1^1/_4$-inch diameter round cores.

auger machine failed to take the output of the pug mill. The judgment of the pug-mill operator was relied on to effect the necessary changes in moisture content. During each such run whenever the column reached what seemed to be the desired hardness, as determined by denting with the finger, a mark was made on the recording wattmeter chart and a sample slab was taken from the column for moisture content determination and the speed of the cutter was counted, all simultaneously.

In each run power determinations were made by connecting an Esterline recording wattmeter into the leads of the 75-H.P. slip ring motor driving the Chambers royal auger machine and cutter only. (The pug mill of this brick machine is a separate unit and is driven by a separate motor.) The arrangement of this instrument is shown in Fig. 5.

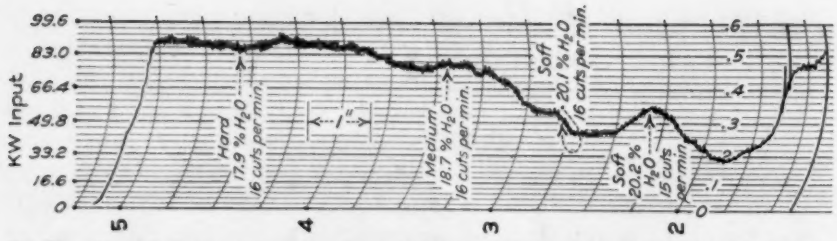

FIG. 7.—Chambers die, only; kw. input to 75-H.P. G. E. motor at Streator (Ill.) Brick Co.; chart speed 1 in./min.

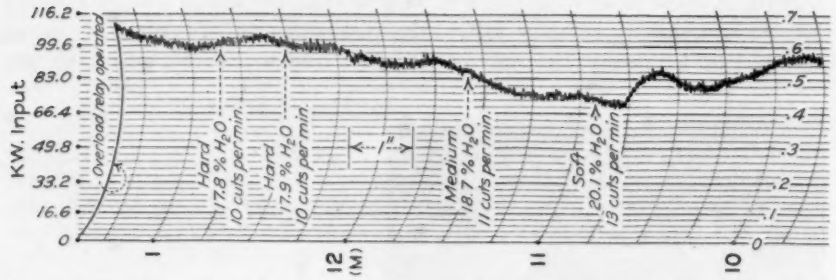

FIG. 8.—Chambers die with cores; kw. input to 75-H.P. G. E. motor at Streator (Ill.) Brick Co.; chart speed 1 in./min.

DATA

Column	H_2O (%)	Chart rdg.	Kw. input	Cuts per min.	Brick per hr.	Kw.-hr. M brick
		Run 803-100 Chambers Die with Cores				
Hard	17.8	0.60	99.5	10	10,200	9.75
Medium	18.7	0.52	86.5	11	11,220	7.87
Soft	20.1	0.44	73.0	13	13,260	5.35
		Run 803-200 Chambers Die Only				
Hard	17.9	0.52	86.5	16	16,420	5.26
Medium	18.7	0.48	80.0	16	16,420	4.88
Soft	20.1	0.32	53.3	15	15,300	3.47
		Run 803 300 Freese Die with Cores				
Hard	17.9	0.58	96.3	13.5	*13,750	7.00
Medium	18.8	0.48	80.0	15	15,300	5.22
Soft	20.1	0.42	70.0	16	16,320	4.30
		Run 803-400 Freese Die Only				
Hard	17.7	0.52	86.5	17.5	17,850	4.84
Medium	18.8	0.42	70.0	17.5	17,850	3.93
Soft	19.9	0.42	70.0	17	17,350	4.04

To compute kw. input
Current transformer ratio = $33\frac{1}{3}:1$
Meter constant = 5
Kw. = $5 \times 33\frac{1}{3} \times$ chart reading = $166.6 \times$ chart reading

To compute brick per hour
1 cut = 17 brick
Brick per hr. = $17 \times 60 \times$ cuts/min. = $1020 \times$ cuts/min.

To compute kw.-hr. per 1000 brick
Kw.-hr. for 1 hr. = kw. input

$$\text{Kw.-hr. per M brick} = \frac{\text{kw. input}}{\text{M brick per hr.}}$$

In 1927, power determinations were made on the same auger machine equipped with Chambers die as in run 803-200 above. In this case an ordinary service type integrating watt-hour meter was connected into the leads of the 75 H.P. motor and the energy consumed was measured over a considerable period of time. The average figure thus obtained was 3.86 kw.-hr. per thousand brick. It will be seen that this figure is in close agreement with the data as above.

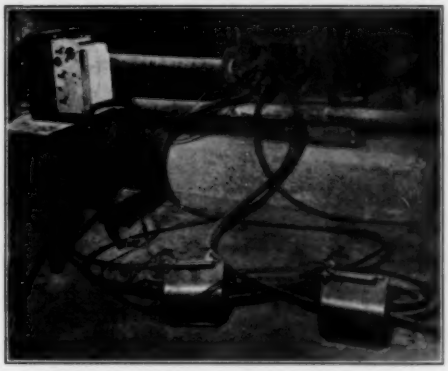

FIG. 9.—Esterline recording wattmeter with hole type current transformers connected into leads to 75-H.P. G. E. slip ring motor driving Chambers auger machine.

The following conclusions can be drawn from the above data:

(1) Power consumption per thousand brick is much greater when cores as described are inserted. This increase amounts to 61% in the case of the Chambers die and 33% in the case of the Freese die.

(2) Power consumption increases more rapidly with decreasing moisture content for the Chambers die with cores than for the Freese die with cores.

(3) The capacity of the brick machine for the given speed and maximum power input that was available was decreased 31.6% for the Chambers die and 14% for the Freese die when the cores described above were inserted.

(4) Power consumption increases with decreasing moisture content for either die.

A SANDBLAST ABRASION TEST FOR GLAZES[1]

By Edward Schramm

ABSTRACT

A method is described for determining the abrasive hardness of glazes by means of a sandblast apparatus. Consistent results are obtained and data are given showing the relative hardness of several types of glaze.

Introduction

Published References Methods for measuring the abrasive hardness of glazes have been developed by the Bureau of Standards and have been reported in two papers.[2] In all the Bureau work the abrasion has been effected by dropping standard sand through a slot on to the specimen which is held stationary and inclined to the sand stream. Scott's measure of abrasion was the loss in weight under standard conditions, while Harrison substituted for the weighing an estimation of the change in gloss by means of an Ingersoll glarimeter and expressed the abrasion resistance as the weight of sand needed to produce 10% reduction in gloss.

The Writer's Experiments At various times, covering a period of some years, devices for abrading glazes had been used for experiments. The first apparatus was a hexagonal tumbler, to the sides of which six plates were fastened; the tumbler was partly filled with broken biscuit and the specimens examined after a certain elapsed time. This afforded a crude qualitative or comparative test. When a more accurate method was wanted the first thought was to retain the tumbler but accurately weigh the plates on a suitable balance before and after abrasion. With a standardizing balance of 2 kg. capacity and high accuracy, suitable weighings could be made but it was soon found that the results of the tumbling were very erratic. A method was then tried of oscillating a single plate in contact with abrasive grains but this likewise proved a failure. Finally, it was decided to try the use of sand through the knowledge of the Bureau of Standards work and through the writer's experience with a large sandblast machine in the factory. Some preliminary experiments were made with the latter but it was found that the effect was much too harsh and uncontrollable to serve as a quantitative test. It seemed probable, however, that the sandblast could be adapted to the purpose and that the necessary features of a good apparatus included: (1) the use of a single stream of sand which must be under control and reproducible; (2) the rotation of the test plate so that a considerable

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (White Wares Division.) Received December 28, 1928.

[2] Scott, *Jour. Amer. Ceram. Soc.*, **7**, 342–46 (1924); Harrison, *Ibid.*, **10**, 77–89 (1927).

area could be covered and a weighable amount removed without cutting too deep into the glaze.

The Sandblast Test

With these requirements in view, the machine shown in side elevation in Fig. 1 was constructed. The sandblast is a single nozzle of the suction type which came equipped with a tapered air nozzle $^{7}/_{32}$ inch in diameter at the discharge end. It was found advantageous to plug this with a steel plug drilled to afford a $^{1}/_{8}$-inch air channel. The construction and operation of the apparatus is obvious from the drawing.

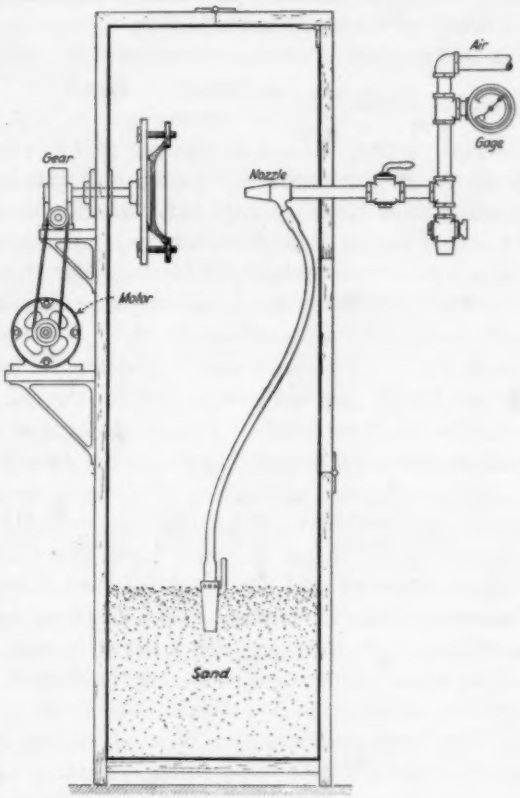

FIG. 1.—Sandblast abrasion test.

The specimen to be tested is centered and mounted on a fiber-faced disk rotated at 35 r.p.m. by a motor through a small reducing gear. The nozzle is permanently fastened in place at the front of the box at an angle of about 60° to the plane of the disk. The sand is contained in the bottom of the box which is zinc lined and can be entirely closed during the test so that there is no dust nuisance.

Ordinary sandblast sand is used, and owing to the large mass used, the effect of the glaze dust on the sand is negligible. The suction nozzle cuts its way into the sand bed and this must be adjusted to approximately the same position before each test.

The air nozzle is permanently piped to a compressed air tank. Pressure is built up in this tank (using a small feather valve compressor) to a point a little above the starting pressure of the test. The compressor is stopped and any excess pressure in the tank released by means of a globe valve

until the desired reading is obtained on the gage. After setting the specimen in rotation the valve on the sandblast nozzle is opened quickly and the pressure allowed to run down to zero when the test is complete. Satisfactory results can be obtained under a large variety of conditions of nozzle opening, air pressure, etc. Tests were made under a number of different conditions while the method was being developed and the results were found comparable. It was found desirable to set aside a considerable quantity of ware of known history to serve as a standard by which the apparatus could be checked occasionally.

Effect of Humidity According to Harrison[2] "the resistance of the glaze (as determined by the sand dropping-glarimeter method) is proportional to the per cent relative humidity of the atmosphere." It is difficult to imagine how this conclusion could have been reached since Harrison gaged the abrading force not by time of flow but by actual weight of sand delivered against the specimen. It seemed necessary, however, to check this factor. For this purpose the regular stock of sand of the following screen analysis was used; rejected on 28-mesh, 0%; on 48-mesh, 39.1%; on 65-mesh, 48.4%; on 100-mesh, 8.4%; through 100-mesh, 3.6%. The sand was sucked from a weighed pail under the conditions finally adopted as standard for the test, initial air pressure 36 lbs. with the small air nozzle. The weight of sand in grams removed from the pail as determined on two days of very different humidity was as follows:

							Average
70% humidity	495	510	515	515	540	525	515
50% humidity	535	510	515	505	510	515	515

It is apparent that the weight of sand delivered is not affected by the humidity of the atmosphere. It is furthermore certain that the operation of the nozzle in testing ware is even more consistent than indicated by the above figures for two reasons: (*a*) the flow of sand to the nozzle is more uniform in the large box than in a pail and (*b*) there is a chance of error in the above weighings due to sand lodging in the suction tube. Tests were carried out with the standard reference ware on days of different humidity. Losses in weight in milligrams are given below:

							Average	Maximum variation from average
77% humidity	148	141	144	140			143	3.5%
40% humidity	140	150	147	141	144	140	144	4.2%

The above figures which are typical of the reproducibility of the test may be compared with the Bureau of Standards results with different wares which gave a maximum variation from the average of 1.5 to 13.5%, and with their results with experimental glazes (Table II) which gave a variation from the average of 8.4 to 34.6% and a general average of this variation for all glazes of 14.9%.

Errors of weighing can be reduced by using a counterpoise of the material under investigation, thus neutralizing changes in the buoyancy of the atmosphere if weighings must be made on different days.

Glaze Comparisons Some results are given with different glazes. The several series are not comparable with one another since the method was gradually evolved to its present form and much data was obtained before the standard conditions were fixed.

With a glaze for vitreous ware, using a large air nozzle and an initial pressure of 35 pounds, successive tests were carried out on the same pieces:

Specimen	1st abrasion	2nd abrasion
A	237 mg.	286 mg.
B	226 mg.	297 mg.

There is an increased loss after the surface has been removed by the first treatment. The less material removed in the test, the closer we shall come to a determination of the actual surface hardness.

The comparative hardness of different types of glazes is indicated in the following which were run with a large nozzle at 30 pounds pressure:

Ware	Loss in weight (mg.)
English earthenware	357
English semivitreous	260
American vitrified china	188
Foreign true porcelain	160

It will be noted that there is a much larger gap between the earthenware and vitrified china glazes than between the latter and the foreign porcelain. The true porcelain glaze loses about 15% less than the vitrified china.

Glost Fire Effects In the course of some work on experimental glazes an opportunity was given to observe the effect of glost fire on abrasion resistance. These tests were made with the apparatus in its final form, using a small air nozzle and an initial pressure of 36 pounds. The figures in the following table represent the averages of 3 tests:

Loss (mg.)				Cone heat treatment
A	B	C	D	
169	169	174	170	7 hard
195	195	192	200	7 half over (long hold)
206	212	217	223	7 half over (short hold)
207	204	196	194	4 half over

The glazes have a somewhat greater abrasive resistance at the high glost fire. Within the normal range of development of these glazes, however, the differences appear insignificant and it hardly appears that the usual variations in glost temperature can have much effect on the hardness of the glaze. From our experience it appears that this property is determined chiefly by glaze composition.

ONONDAGA POTTERY CO. LABORATORY
SYRACUSE, N. Y.

AN INVESTIGATION OF TWENTY-ONE SASKATCHEWAN BALL CLAYS[1]

By W. G. Worcester [2]

ABSTRACT

Twenty-one Saskatchewan ball clays have been investigated; the study covers in a general way their chemical, raw, and fired properties. The information presented will no doubt prove of immediate interest to the ball clay trade and especially to the Saskatchewan shippers and exporters.

In general, the more outstanding properties of the clays studied are raw strength, fired color, craze resistance, and rate of vitrification.

Their raw strength is remarkably high, greater than that of any similar clay on the market at the present time. One clay developed the exceptional raw strength, though diluted with 50% potters' flint, of over 1000 lbs. per square inch, a second one 938 lbs., while the average of the eleven highest is 812.8 lbs.; clays of such high strength should prove of interest to the trade where it is desirable to reduce losses in the raw and bisque state.

A number of the clays tested are outstanding as ball clays in that they fire white or nearly so up to and including cone 12, the purity of whiteness being equal to that of white firing china clays.

The porosity and fired volume shrinkage of the Saskatchewan clays correspond more nearly to those of the English ball clays than do the Tennessee-Kentucky clays as studied by Sortwell.

Introduction

Information concerning the clays of Saskatchewan that fire to a light color has been meager. The existence of these clays has been known for many years. Dr. Bell[3] made mention of them in his report on the coal seams of the Dirt Hills (Sask.). It is not likely that Dr. Bell attached any importance to the clays.

The first test of the Saskatchewan light clays was conducted in 1907 by Edward Orton, Jr., on twenty-seven samples of clay collected from the Dirt Hills by Daniel Diver.[4]

The first official report of these clays was given by Ries and Keele.[5] This was followed in 1918 by a more detailed report by N. B. Davis.[6]

The work of Davis awakened a ceramic interest in Saskatchewan and this led to the establishment of the Ceramic Department at the Saskatche-

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (White Wares Division.) Received January 2, 1929.

By permission of the Deputy Minister, Department of Railways, Labour, and Industries of the Saskatchewan Government, Regina, Sask.

[2] Prof. Ceramic Eng., Univ. of Sask., Saskatoon, Sask.

[3] Dr. Bell, Report of Progress, Geological Surv., Can., 1873–74.

[4] Prospector.

[5] Ries and Keele, The Clay and Shale Deposits of the Western Provinces, 1912.

[6] N. B. Davis, Report on the Clay Resources of Southern Sask. Dept. of Mines, Canada.

wan University in coöperation with the Department of Railways, Labour, and Industries of the Provincial Government, the activities to be not wholly academic but also to conduct surveys and research work on the clays of the province.

A study of twenty-one Saskatchewan ball clays was one of the surveys made.

The field collection of the samples and much of the research was completed in 1924. All samples and records were destroyed in the disastrous fire at the University in 1925.

The Laboratory Investigation

Preparation of Samples Care was used to procure an average sample of each clay at the deposit. On arrival at the laboratory they were allowed to room dry. One hundred pounds of each were crushed in rolls, slowly fed into a tank of water, and soaked for 24 hours, then thoroughly blunged, screened through a 160-mesh Tyler brass screen, allowed to settle, the excess water siphoned off, the slip thoroughly stirred and forced into a filter press by compressed air. The filter-pressed cakes of each were dried to a point where they could be recrushed and dry screened through 8-mesh, the batch thoroughly dry mixed, water added, and the mass wedged on plaster and packed into large stone-ware jars, covered, and allowed to age for forty-eight hours. After rewedging all trial pieces were prepared in as short a time as possible, the same assistant making the same trial pieces from clay to clay, thus avoiding insofar as possible any variations. To further avoid chances of error there were made ten trial pieces for each test or measurement and the average taken as the final figure.

Tests Made (1) *Chemical:* Six clays were selected for this.

(2) *Elutriation:* The percentage and size of particles in each sample finer than 200-mesh were determined. The apparatus used was patterned after Schultz, though the construction and operation followed Krehbiel.[7]

(3) *Hydrogen-Ion Concentrations:* The values for the several clays were determined in a La-Motte roulette comparator. A quantity of ground clay was placed in a quart fruit sealer with sufficient distilled water to make a thin slip, the sealer placed in the frame of a ball mill in such a position that at each revolution of the mill the clay slip was thrown or splashed from end to end of the sealer for two hours. The clay was then allowed to settle and the determinations made.

(4) *Water of Plasticity:* The samples were hand pressed in a steel mold,

[7] *Trans. Amer. Ceram. Soc.*, **6**, 173–85 (1904).

11 by 1 by 1 inch, and cut into trials, $2^1/_2$ by 1 by 1 inch. They were weighed immediately and, after drying at 110°C, cooled in a desiccator.

(5) *Per Cent of Shrinkage and Pore Water:* These were determined by the Standard Method of the AMERICAN CERAMIC SOCIETY.

The wet and dry volumes were taken of the trial pieces used in obtaining the water of plasticity, thus it was only necessary to apply the following formulas:

$$\text{Shrinkage water} = t_1 = \frac{V_p - V_d}{W_d} \times 100$$

Where t_1 = the percentage of shrinkage water
V_p = the plastic volume in cu. cm.
V_d = the dry volume in cu. cm.
W_d = the dry weight in grams

$$\text{Pore water} = t_2 = T - t_1$$

Where t_2 = the percentage pore water
T = the percentage water of plasticity

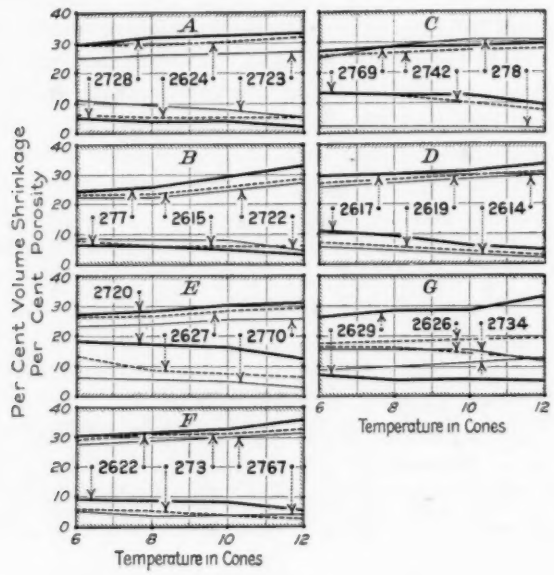

FIG. 1.

(6) *Volume Drying Shrinkage:* The volume drying shrinkage was determined on trial pieces, $1^1/_8$ by $1^1/_8$ by $1^7/_8$ inches. The freshly made trials were placed at once in a kerosene bath, their green volume measured in a Schurecht overflow volumeter, room dried at 65°C and 110°C, and cooled in a desiccator, soaked in oil for 24 hours, and their dry volume taken as before. The percentage of drying shrinkage was calculated on the wet volume.

(7) *Transverse Strength of the Raw Clay:*[8] Ten bars, 6 by 1 by 1 inch, were made of each clay in its raw plastic state; in addition, a second portion was dried, pulverized, and carefully blended with 50% potters' flint, tempered, and then made into trial pieces similar to the above. All of these were dried at room temperature and finally at 110°C, cooled in a desiccator and broken transversely; the moduli of rupture were calculated by the usual formula.

(8) *Transverse Strength—Clay-Flint Mixture:* For this test the clays were first blunged and screened through 160-mesh, dried at 65°C, crushed through a 20-mesh screen, then blended with potters' flint in equal parts by weight. The mixture, after tempering, was thoroughly wedged and allowed to age for 24 hours. Twenty trials, $1^1/_8$ by $1^1/_8$ by 7 inches, were then molded, room dried and finally dried at 65 and 110°C. Ten of them were cooled in a desiccator followed by cross-breaking in a simple lever-type machine, using running shot to apply the load, 100 lbs. per minute. The remainder of the trials were fired in a commercial brick kiln to cone 8 and then broken in the same manner as the raw trials.

(9) *Volume Firing Shrinkage:* Forty trials, $1^1/_8$ by $1^1/_8$ by $1^7/_8$ inches, were prepared from each clay, their wet and dry volumes were taken, then ten of each were fired to cones 6, 8, 10, and 12 and their fired volumes determined, the per cent of shrinkage being calculated as per cent on the wet and dry basis.

(10) *Absorption and Apparent Porosity:* Sets of ten trials of each clay, $1^1/_8$ by $1^1/_8$ by $1^7/_8$ inches, were prepared for firing at cones 4, 6, 8, 10, 12, and 14, in an updraft muffle kiln fired with oil, the firing periods ranging from 30 to 40 hours. The trials were weighed at once when taken from the kiln, then placed in water with one face exposed for twenty-four hours, the water brought up to and held at boiling point for two hours, then allowed to cool, each trial wiped free of excess water, and weighed. The per cent absorption was calculated on the dry weight. The suspended weight in water was taken of the absorption trial pieces so that the per cent apparent porosity could be calculated by Purdy's formula:

$$P = \frac{W - D}{W - S} \times 100$$

Where P = per cent apparent porosity
W = weight of the saturated test piece
D = " " " dry-fired " "
S = suspended weight of the fired test piece

(11) *Apparent Specific Gravity:* The figures for the apparent specific gravity of the several clays were obtained from the dry and suspended

[8] It was found, with two or three exceptions, that the clays could not be dried free of checks; therefore the results were very misleading and are not published.

weights of the fired volume shrinkage trials, using the formula and method of Purdy.[9]

$$\text{Apparent specific gravity} = \frac{\text{Dry weight}}{\text{Dry weight} - \text{susp. weight}}$$

(12) *Transverse Strength after Firing Clay-Flint Mixture:* Ten trial pieces of each clay were fired at cone 8 in a commercial firebrick kiln. Upon their return to the laboratory they were placed in a drying oven for twenty-four hours, cooled in a desiccator, then broken transversely, and their moduli of rupture determined by the usual formula.

(13) *Color after Glazing:* Disks of the plastic clay were jiggered in plaster molds $^5/_{16}$ inch deep and 10 inches in diameter. The disks were cut with a $3^1/_2$-inch diameter-cutter into the desired trial pieces and dried away from dust, then fired at cones 4, 8, and 12. Five of the trials from each firing were glazed with a standard borosilicate glaze kindly supplied by the Homer-Laughlin China Company of Newell, W. Va. The trials were then placed in saggers and fired in a muffle kiln to cone 2 in twelve hours.

(14) *Resistance to Crazing:* The glazed trials of each clay used in the color study were placed in an electrically heated oven having a thermostatic control capable of maintaining a temperature within $^1/_4$°C ±. The temperature was held at 225°C, being a spread of 210°C from that of the water used for quenching. After the oven and trials had been held at the desired temperature for one hour the trials were taken from the oven and immersed at once into running water at 15°C. When the trials were at the water temperature they were at once returned to the oven. This was repeated five times.

(15) *Oxidation:* For this test briquets, $1^1/_4$ by $1^1/_4$ by 2 inches, were made, dried, and then placed in the muffle of an oil-fired kiln and raised steadily in temperature to 750°C in five hours and then held constant at that temperature. Trials of each clay were drawn hourly, though in a few cases at half-hour intervals, until the clay requiring the longest period of oxidation showed no further traces of unoxidized material. The time required for oxidation has been plotted for comparison against the results obtained by Sortwell[10] in a similar test on English and United States ball clays.

(16) *Fusion Test:* Cones were made of the several clays after washing. When dry the cones were calcined. The actual fusion determinations were made in a bottom-fired oxyacetylene furnace[11] as described by Gorton and Groves.

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[9] R. C. Purdy, Ill. Geol. Surv., *Bull.*, No. 9.

[10] U. S. Bur. Stand., *Tech. Paper*, No. 227.

[11] *Jour. Amer. Ceram. Soc.*, **8** [11], 768–73 (1925).

Results

TABLE I

CHEMICAL ANALYSIS

Ceramic Dept. No. / Chemistry Dept. No.	2617 54/27	2622 55/27	2624* 56/27	2629* 57/27	2611 70/27	2619 71/27
Loss on ignition	11.66	13.665	13.02	9.16	13.56	12.45
Silica (SiO_2)	56.92	51.285	54.31	65.14	54.49	55.63
Alumina (Al_2O_3)	28.96	32.70	28.77	28.87	28.89	29.36
Titania (TiO_2)	1.02	0.68	0.78	1.05	0.75	0.82
Iron (Fe_2O_3)	0.85	0.69	0.81	0.73	0.79	0.90
Lime (CaO)	0.58	0.78	0.98	Trace	1.08	0.56
Magnesia (MgO)	0.25	0.30	0.65	0.33	0.62	0.35
Alkalis (Na_2O)	0.21	0.43	0.90	0.10	0.02	0.23
Total	100.45	100.53	100.22	100.38	100.20	100.30

* Unwashed

TABLE II

ELUTRIATION AND WASHING

No.	Per cent on 200-mesh	Per cent in No. 1 can	Per cent in No. 2 can	Per cent in No. 3 can	Per cent total sands	Per cent clay substance
2614	5.1	1.1	2.9	10.9	20.0	80.0
2615	5.3	2.5	5.4	8.4	21.6	78.4
2617	3.7	1.0	3.3	5.9	13.9	86.1
2619	5.2	2.0	5.1	8.4	20.7	79.3
2622	3.4	1.0	2.9	7.0	14.3	85.7
2624	5.5	0.8	4.5	8.5	19.3	80.7
2626	14.3	5.4	4.9	10.4	35.0	65.0
2627	3.2	0.0	3.5	10.0	16.7	83.3
2629	6.1	1.2	2.8	4.6	14.7	85.3
273	3.4	1.6	4.8	8.6	18.4	81.6
277	4.7	2.4	4.5	7.3	18.8	81.2
278	5.2	0.6	1.6	6.6	14.0	86.0
2720	42.1	1.6	1.5	1.5	46.9	53.1
2722	5.6	1.9	2.8	5.9	16.2	83.8
2723	2.9	8.2	4.3	8.0	23.4	76.6
2728	6.0	2.7	7.2	10.3	26.2	73.8
2734	4.8	5.7	7.2	11.1	28.8	71.2
2742	4.6	2.8	5.6	9.8	22.8	77.2
2767	5.0	2.1	1.5	2.7	11.3	88.7
2769	3.1	1.6	4.2	12.6	21.5	78.5
2770	6.1	0.6	3.4	10.6	20.7	79.3

TABLE III

HYDROGEN-ION CONCENTRATIONS

Clay no.		Clay no.	
2614	7.6	278	7.4
2615	7.0	2720	6.6
2617	6.6	2722	7.8
2619	6.6	2723	6.4
2622	6.9	2728	6.0
2624	7.3	2734	8.0
2626	7.2	2742	7.3
2627	7.9	2767	8.0
2629	7.7	2769	6.6
273	7.1	2770	6.2
277	7.4		

TABLE IV

PER CENT WATER OF PLASTICITY

Clay no.	Per cent on wet basis	Per cent on dry basis	Clay no.	Per cent on wet basis	Per cent on dry basis	Clay no.	Per cent on wet basis	Per cent on dry basis
2614	25.5	34.2	2627	28.7	40.3	2723	28.9	40.7
2615	25.0	33.4	2629	24.6	32.6	2728	27.7	38.9
2617	24.8	32.9	273	26.3	35.7	2734	21.9	28.1
2619	22.3	27.5	277	27.9	38.7	2742	25.1	33.5
2622	25.5	34.3	278	29.3	38.1	2767	28.7	39.7
2624	27.9	38.6	2720	29.3	41.4	2769	24.5	32.5
2626	24.0	31.7	2722	25.2	49.1	2770	24.7	33.1

TABLE V

PER CENT PORE AND SHRINKAGE WATER

Clay no.	Per cent pore water	Per cent shrinkage water	Clay no.	Per cent pore water	Per cent shrinkage water
2614	16.62	17.60	278	15.10	26.40
2615	16.64	16.80	2720	19.00	22.40
2617	17.97	15.01	2722	11.46	22.24
2619	7.85	20.95	2723	17.35	23.40
2622	16.58	17.80	2728	16.65	21.75
2624	13.12	25.55	2734	12.59	15.51
2626	14.68	16.02	2742	14.69	18.91
2627	14.18	26.20	2767	18.53	21.67
2629	14.39	18.29	2769	16.75	15.80
273	15.94	19.82	2770	15.81	17.30
277	14.88	23.82			

TABLE VI

PER CENT DRYING SHRINKAGE

	Volume shrinkage		Linear shrinkage			Volume shrinkage		Linear shrinkage	
No.	Wet basis	Dry basis	Wet basis	Dry basis	No.	Wet basis	Dry basis	Wet basis	Dry basis
2614	25.1	33.5	9.18	10.11	278	33.5	50.6	12.72	14.62
2615	23.4	30.5	8.50	9.28	2720	28.7	40.2	10.66	11.92
2617	22.9	29.7	8.30	9.06	2722	29.4	41.6	10.96	12.29
2619	27.8	38.6	10.29	11.49	2723	29.8	42.5	11.13	12.53
2622	24.8	33.0	9.06	9.97	2728	28.6	40.0	10.62	11.92
2624	31.8	46.7	11.98	13.62	2734	23.7	31.2	8.62	9.47
2626	23.7	31.0	8.62	9.42	2742	25.4	33.9	9.31	10.22
2627	33.3	49.9	12.63	14.44	2767	27.8	38.5	10.29	11.47
2629	25.7	34.6	9.43	10.41	2769	22.1	28.4	7.99	8.69
273	26.8	36.7	9.88	10.98	2770	24.2	31.9	8.82	9.67
277	29.5	41.9	11.00	12.37					

TABLE VII

MODULUS OF RUPTURE OF UNFIRED TRIALS

No.	50% clay 50% flint	No.	50% clay 50% flint	No.	50% clay 50% flint
2614	745	2627	938	2723	882
2615	566	2629	757	2728	846
2617	679	273	722	2734	661
2619	652	277	727	2742	601
2622	754	278	796	2767	1008
2624	766	2720	459	2769	440
2626	513	2722	612	2770	609

TABLE VIII

PER CENT LINEAR FIRING SHRINKAGE, WET AND DRY BASIS

Clay no.	Cone 6		Cone 8		Cone 10		Cone 12	
	Wet basis	Dry basis	Wet basis	Dry basis	Wet basis	Dry basis	Wet basis	Dry basis
2614	7.36	8.41	7.71	8.75	8.07	9.11	8.19	9.16
2615	6.33	7.20	6.40	7.29	7.09	7.98	7.52	8.38
2617	8.50	9.25	8.70	9.39	8.94	9.64	9.43	10.05
2619	7.28	8.61	7.71	9.03	7.87	9.20	8.19	9.50
2622	8.27	9.22	8.74	9.70	9.06	9.97	9.67	10.52
2624	7.13	8.92	7.17	8.94	7.40	9.20	7.83	9.64
2626	4.61	5.46	4.76	5.61	4.94	5.82	5.13	6.00
2627	6.25	8.10	6.33	8.21	6.78	8.72	6.86	8.80
2629	7.13	8.21	7.64	8.72	7.71	8.77	8.78	9.81
273	7.91	9.11	7.91	9.11	8.30	9.47	8.70	9.86
277	6.02	7.46	6.33	7.81	7.17	8.69	8.11	9.67
278	6.75	7.87	7.09	9.11	7.17	9.17	7.36	9.39
2720	6.90	8.35	7.17	8.72	7.87	9.31	7.91	9.34
2722	5.42	6.80	5.65	7.03	6.21	7.66	6.78	8.29
2723	6.10	7.61	6.52	8.01	6.63	8.15	6.82	8.35
2728	7.64	9.06	8.15	9.58	8.34	9.75	8.54	9.97
2734	2.36	2.95	2.67	3.29	2.88	3.54	3.20	3.91
2742	7.01	8.07	7.28	8.35	7.52	8.58	7.52	8.58
2767	6.90	8.24	7.32	8.66	7.79	9.14	8.30	9.64
2769	7.60	8.32	8.07	8.77	8.19	8.86	8.19	8.89
2770	6.14	7.09	6.33	7.29	6.82	7.78	6.90	7.87

TABLE IX

PER CENT VOLUME FIRING SHRINKAGE ON WET AND DRY BASIS

No.	Cone 6		Cone 8		Cone 10		Cone 12	
	Wet basis	Dry basis	Wet basis	Dry basis	Wet basis	Dry basis	Wet basis	Dry basis
2614	20.5	27.4	21.4	28.6	22.3	29.8	22.6	30.2
2615	17.8	23.2	18.0	23.5	19.8	25.9	20.9	27.3
2617	23.4	30.4	23.9	30.9	24.5	31.8	25.7	33.3
2619	20.3	28.1	21.4	29.6	21.8	30.2	22.6	31.3
2622	22.8	30.3	24.0	32.0	24.8	33.0	26.3	35.0
2624	19.9	29.2	20.0	29.3	20.6	30.2	21.7	31.8
2626	13.2	17.3	13.6	17.8	14.1	18.5	14.6	19.1
2627	17.6	26.3	17.8	26.7	19.0	28.5	19.2	28.8
2629	19.9	26.7	21.2	28.5	21.4	28.7	24.1	32.4
273	21.9	29.9	21.9	29.9	22.9	31.2	23.9	32.6
277	17.0	24.1	17.8	25.3	20.0	28.4	22.4	31.9
278	18.9	25.5	19.8	29.9	20.0	30.1	20.5	30.9
2720	19.3	27.2	20.0	28.0	21.8	30.6	21.9	30.7
2722	15.4	21.8	16.0	22.6	17.5	24.8	19.0	27.0
2723	17.2	24.6	18.3	26.0	18.6	26.5	19.1	27.2
2728	21.2	29.7	22.5	31.5	23.0	32.2	23.5	33.0
2734	6.9	9.1	7.8	10.2	8.4	11.0	9.3	12.2
2742	19.6	26.2	20.3	27.2	20.9	28.0	20.9	28.0
2767	19.3	26.8	20.4	28.3	21.6	30.0	22.9	31.8
2769	21.1	27.1	22.3	28.7	22.6	29.0	22.6	29.1
2770	17.3	22.8	17.8	23.5	19.1	25.2	19.3	25.5

TABLE X

PER CENT ABSORPTION

Clay no.	Cone 4	Cone 6	Cone 8	Cone 10	Cone 12	Cone 14
2614	3.39	3.21	2.14	2.57	0.96	0.50
2615	5.76	5.70	5.68	4.15	3.03	0.39
2617	5.21	4.92	4.57	4.02	2.41	1.57

TABLE X (*continued*)

Clay no.	Cone 4	Cone 6	Cone 8	Cone 10	Cone 12	Cone 14
2619	3.87	3.35	2.78	2.48	1.27	0.82
2622	5.70	5.42	4.11	3.90	1.66	1.39
2624	3.21	2.42	1.95	1.95	1.90	1.82
2626	8.22	8.19	8.15	7.08	5.66	3.48
2627	2.54	2.42	2.30	2.13	1.57	1.05
2629	3.25	2.41	2.34	2.02	1.86	1.71
273	3.04	3.19	2.31	2.01	1.12	0.81
277	5.66	4.72	4.28	3.92	1.68	1.05
278	0.54	0.52	0.42	0.40	0.21	0.20
2720	9.75	8.47	7.81	7.61	5.40	1.56
2722	5.80	4.76	4.52	4.09	2.14	1.84
2723	5.45	5.00	4.51	4.10	2.41	1.41
2728	2.57	2.30	1.46	1.42	1.33	1.23
2734	8.12	8.06	7.80	7.80	5.63	1.97
2742	6.15	5.62	5.00	4.09	2.95	2.58
2767	3.44	2.05	1.95	1.84	1.63	1.29
2769	6.52	5.15	4.72	4.57	3.41	2.33
2770	6.22	5.30	3.95	4.64	2.85	1.61

TABLE XI

PER CENT APPARENT POROSITY

No.	Cone 4	Cone 6	Cone 8	Cone 10	Cone 12	Cone 14
2614	7.25	6.70	5.34	4.56	2.18	1.10
2615	12.43	8.97	7.94	7.13	6.68	0.88
2617	12.10	11.57	10.26	7.81	5.52	3.89
2619	8.22	7.03	6.26	4.22	2.65	1.90
2622	12.96	10.20	9.11	8.45	3.94	3.18
2624	7.00	5.93	4.30	4.30	4.20	4.13
2626	16.60	16.53	16.35	14.20	12.06	9.63
2627	5.62	5.44	5.00	4.65	3.62	2.76
2629	7.20	4.85	4.85	4.41	3.76	2.86
273	7.06	6.15	5.40	4.21	2.75	1.75
277	11.93	8.29	7.85	6.20	3.34	2.68
278	1.21	1.10	1.04	0.87	0.51	0.50
2720	19.90	17.70	16.60	15.50	11.80	3.40
2722	11.93	9.10	9.11	9.05	5.65	4.10
2723	11.83	10.86	9.61	8.21	5.52	3.18
2728	6.31	4.76	3.59	3.19	2.45	2.24
2734	16.33	16.19	15.70	15.70	11.42	4.15
2742	13.50	12.20	11.17	9.92	6.85	6.03
2767	7.40	5.15	4.36	4.02	3.30	2.79
2769	14.70	12.14	11.36	11.04	8.74	7.26
2770	13.23	12.50	8.86	7.85	6.70	4.89

TABLE XII

APPARENT SPECIFIC GRAVITY

No.	Cone 4	Cone 6	Cone 8	Cone 10	Cone 12
2614	2.16	2.21	2.34	2.30	2.37
2615	2.11	2.18	2.13	2.14	2.16
2617	2.20	2.25	2.27	2.24	2.32
2619	2.27	2.27	2.34	2.28	2.33
2622	2.21	2.31	2.24	2.25	2.38
2624	2.29	2.37	2.29	2.32	2.36
2626	2.02	2.08	2.01	2.05	2.09
2627	2.24	2.30	2.27	2.28	2.31
2629	2.22	2.33	2.26	2.35	2.33
273	2.24	2.33	2.34	2.28	2.39
277	2.11	2.24	2.20	2.14	2.27
278	2.40	2.47	2.44	2.41	2.43
2720	2.03	2.13	2.11	2.07	2.17
2722	2.13	2.25	2.22	2.21	2.22

No.	Cone 4	Cone 6	Cone 8	Cone 10	Cone 12
2723	2.12	2.18	2.19	2.22	2.21
2728	2.34	2.40	2.41	2.09	2.25
2734	1.97	1.98	1.99	2.03	2.02
2742	2.21	2.27	2.26	2.21	2.34
2767	2.18	2.29	2.27	2.27	2.28
2769	2.19	2.27	2.28	2.33	2.27
2770	2.19	2.25	2.27	2.24	2.30

TABLE XIII

MODULUS OF RUPTURE OF FIRED TRIALS, CONE 8

(50% clay—50% flint)

No.	Lb.	No.	Lb.	No.	Lb.
2614	2396.0	2627	1715.6	2723	2113.0
2615	2121.6	2629	2199.3	2728	2614.0
2617	2363.0	273	2794.3	2734	1760.6
2619	1591.5	277	2017.0	2742	2433.3
2622	2201.6	278	2307.3	2767	2145.0
2624	2661.0	2720	1751.6	2769	1541.6
2626	2092.6	2722	2520.6	2770	2328.3

TABLE XIV

COLOR AFTER GLAZING

No.	Cone 4	Cone 8	Cone 12
2614	Light cream; many small black specks	A darker shade of cream; specks more pronounced	A light bluestone; specks more pronounced
2615	A clear light cream; specks just visible	A deeper shade of cream; many light brown specks	Practically the same as cone 8 trials
2617	A creamy white; a few dark specks	Same shade of white; specks numerous	Slightly darker shade; specks more pronounced
2619	A deep cream; numerous small specks	Slightly deeper shade; specks numerous	Bluestoned throughout; specks quite black
2622	Nearly white; specks can be seen only with a glass	A light cream white; few small yellowish specks	Practically the same as cone 8 trials
2624	Nearly white; specks seen only by use of a glass	Practically the same as cone 4 trials	Bluestoned throughout; a glass needed to see specks
2626	A light cream; a few specks just visible	Same shade as cone 4; specks more pronounced	A deep cream; numerous yellowish specks
2627	A medium cream; numerous specks showing	Practically the same as cone 4; specks are darker	Trials are starting to bluestone; specks same as cone 8
2629	A dark cream or ivory; a few specks showing	A much darker shade; specks quite pronounced	Bluestoned throughout; specks same as cone 8
273	A clear light cream; no specks	A much deeper shade; yellowish specks	Same as cone 8
277	A light ivory or cream; no specks	About the same shade; a few specks showing	A deep ivory and signs of bluestoning; a very few specks
278	A yellowish white with many specks	A light bluestoning; many specks	A deep bluestoning; many black specks

TABLE XIV (*continued*)

No.	Cone 4	Cone 8	Cone 12
2720	Light creamy white; few specks	Slightly lighter shade; specks more pronounced	Shade same as cone 4 though specks show more plainly
2722	An ivory tint; badly specked	Same as cone 4 trials	A darker shade, otherwise the same as cones 4 and 8 trials
2723	A clear light cream; no specks	Just a shade darker; a few odd specks	Bluestoned; a few specks showing
2728	A light creamy white; no specks	A darker cream color; only an odd speck	Bluestoned, an odd speck or so
2734	A very deep clear cream; no specks	A slightly lighter shade; yellowish specks showing	A deep yellowish cream; specks same as cone 8 trials
2742	Nearly white; no specks	A slight cream tint and a few specks	Practically the same as cone 8 trials
2767	A light cream with light brown specks	A lighter shade though starting to bluestone	Bluestoned throughout; clear of specks
2769	A creamy white, free of specks	A deeper shade and specks showing	Practically the same as cone 8
2770	Nearly white, free of specks	Same in shade, few specks showing	Shade only slightly changed; specks same as cone 8

Best White or Nearly White at

Cone 4	Cone 8	Cone 12
2617	2617	2622
2622	2622	2742
2624	2624	2770
273	2742	
2728	2769	
2742		
2769		
2770		

Best Light Cream or Ivory at

Cone 4	Cone 8	Cone 12
2615	2619	2720
2619	2626	
2626	2627	
2627	277	
277	2720	
2720	2722	
2722	2723	
2723		
2767		

Best Deep Cream or Ivory at

Cone 4	Cone 8	Cone 12
2734	2728	277
	2734	2722
	2769	2734
		2769

Bluestoned at

Cone 8	Cone 12	Cone 12
278	2614	277 (slight)
2767	2619	278
	2624	2723
	2627 (slight)	2728
	2629	2767

Clays Speck Free at

Cone 4	Cone 4	Cone 8	Cone 12
2622	2734	None	None
2624	2742		
273	2769		
2723	2770		
2728			

Clays Lowest in Specks at

Cone 4	Cone 8	Cone 8	Cone 12
2615	2622	2767	2622
2626	2624	2770	2624
2629	277		277
2720	2723		2723
	2728		2728
	2742		2742
			2767
			2770

TABLE XV

RESISTANCE TO CRAZING

No.	Cone 4	Cone 8	Cone 12
2614	20% S.C. 80% N.C.	100% N.C.	60% S.C. 40% N.C.
2615	33% S.C. 66% N.C.	100% N.C.	20% S.C. 80% N.C.
2617	100% S.C.	50% S.C. 50% N.C.	20% S.C. 80% N.C.
2619	20% S.C. 80% N.C.	50% S.C. 50% N.C.	100% N.C.
2622	100% N.C.	40% C. 60% N.C.	100% N.C.
2624	100% N.C.	100% N.C.	100% N.C.
2626	40% S.C. 60% N.C.	100% N.C.	100% N.C.
2627	20% S.C. 80% N.C.	100% N.C.	100% N.C.
2629	100% N.C.	50% S.C. 50% N.C.	100% N.C.
273	100% N.C.	80% S.C. 20% N.C.	60% S.C. 40% N.C.
277	80% S.C. 20% N.C.	100% N.C.	100% N.C.
278	100% S.C.	100% N.C.	100% N.C.
2720	100% B.C.	100% C.	50% S.C. 50% N.C.
2722	20% C. 80% N.C.	60% S.C. 40% N.C.	60% S.C. 40% N.C.
2723	35% S.C. 65% N.C.	100% N.C.	100% N.C.
2728	40% C. 60% N.C.	100% N.C.	80% S.C. 20% N.C.
2734	100% S.C.	65% S.C. 35% N.C.	75% S.C. 25% N.C.
2742	100% N.C.	40% S.C. 60% N.C.	80% S.C. 20% N.C.
2767	60% S.C. 40% N.C.	100% N.C.	25% S.C. 75% N.C.
2769	33% C. 66% N.C.	100% N.C.	100% S.C.
2770	40% S.C. 60% N.C.	75% C. 25% N.C.	100% C.

Key:

C.: Normal crazing.
S.C.: Slight crazing.
B.C.: Badly crazed.
N.C.: No crazing.

TABLE XVI

TIME REQUIRED FOR OXIDATION AT 750°C

Laboratory no.	Hours required to oxidize at 750°C	Remarks
2614	2	Very little oxidation necessary
2615	1½	Oxidation required practically nil
2617	3½	Easily oxidized
2619	7	Fairly difficult to oxidize
2622	4	Easily oxidized
2624	8	Quite difficult to oxidize
2626	2½	Oxidation required practically nil
2627	8	Difficult to oxidize
2629	4	Only slightly difficult to oxidize
273	3	Slight oxidation only required
277	14	Very difficult to oxidize
278	5	Fairly easy to oxidize
2720	3	Very easy to oxidize
2722	4½	Fairly easy to oxidize
2723	22	Very difficult to oxidize
2728	4	Fairly easy to oxidize
2734	2½	Slight oxidation only required
2742	5	Fairly easy to oxidize
2767	15	Very difficult to oxidize
2769	4	Readily oxidized
2770	7	Fairly easy to oxidize

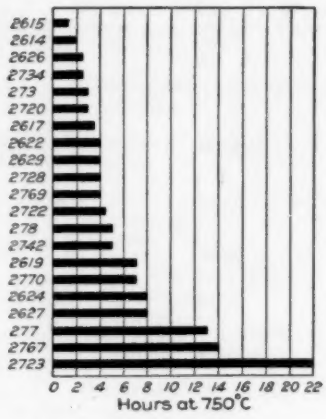

FIG. 2.—Time required for oxidation.

TABLE XVII

FUSION POINT

(P.C.E.)

No.	Cone	°C	No.	Cone	°C	No.	Cone	°C
2614	32	1705*	2627	30+	1678	2723	31+	1695
2615	31	1685	2629	31	1685	2728	32	1705
2617	32+	1712	273	31+	1695	2734	27	1620
2619	31	1685	277	31	1685	2742	32+	1712
2622	33	1720	278	31	1685	2767	31	1685
2624	31+	1695	2720	32+	1712	2769	32	1705
2626	30	1670	2722	31	1685	2770	32+	1712

* Revised scale, U. S. Bureau of Standards.
Note: All clays washed through 160-mesh.

General Geological Section—Southern Saskatchewan

That the geological position of the Saskatchewan ball clays may be noted the following outline or general section* is given.

Glacial	Surface	
Cypress Hills	Oligocene	Tertiary
Ravenscrag, Whitemud, Estevan	Fort Union (Eocene)	Tertiary
Pierre, Foxhills, Belly River	Montana	Cretaceous

*Davis, 1916, Clay Resources of Southern Saskatchewan.

GEOLOGICAL SECTIONS OF DEPOSITS

2614

	Ft.	In.
Glacial and Ravenscrag	30–40	0
Clayish lignite, iron-stained	3	0
2614, light gray plastic clay	9	0
White plastic clay	10	0
Iron streak		
Unknown		

2615
2617

Glacial and Ravenscrag	15	0
Lignite	1	3
2617, purple to yellowish gray plastic (iron stain and concretions)	17	0
2615, white plastic clay (fine concretions)	10	0
Lead gray sandy clays (Estevan)	?	

2619

Glacial and Ravenscrag	25	0
Lignite	2	0
Dark chocolate clay	3	0
2619, light gray, purplish tinge plastic clay (iron-stained)	4	0
Gray clay fine iron concretions	5	0
Lead gray sandy clays (Estevan)	?	

2622

Glacial and Ravenscrag	15	0
Lignite	0	6
2622, purple plastic clay (iron concretions)	8	8
Silty shale, light brown	3	0
Lignite	1	0
Dark gray gritty clay	4	0
Gray sandy clay	3	0
Unknown		

2624*

Glacial and Ravenscrag	4–20	0
2624, purple plastic, grayish	4	0
Unknown		

*From drift mine

2626
2627

Glacial and Ravenscrag	20	0
Lignite	2	6
2627, light gray gritty clay	6	0
2626, light gray gritty clay	3	0
White sandy clay coarse grain	14	0
Unknown		

2629

Glacial and Ravenscrag	25	0
Sandy gray shale	12	0
Lignite	1	0
Yellowish shaly clay	4	0
2629, dark gray, gritty clay (black stems)	5	0
Yellowish to gray shaly clay	4	0
Lead gray sandy clays (Estevan)	?	

2728

Glacial and Ravenscrag	0–30	0
2728, grayish purple plastic	10	0
White clay, iron-stained	6	0
Grayish sandy clay, black stems	6	0
Dark rusty shale	2	0
White sandy clay	12	0
Unknown		

2734*

Alluvial and Ravenscrag	0–6	0
Lignite clay	3	0
Purplish to dark clay	1	0
Light gray nearly white clay	1	6
2734, blue plastic clay, gritty	3	0
Coarse sandy blue clay	4	0
Unknown		

* Taken from a test pit in valley, clay carries under deep cover in valley sides.

273*

Glacial and Ravenscrag	10–30	0
273, gray clay, purplish tint	4	0
Unknown		

* From drift mine

277
278

Glacial and Ravenscrag		30	0
Lignite		2	0
278	Dark gray clay	2	0
	Light gray clay	2	0
	Iron seam (discarded)	0	10
	Gray clay (Iron stain near base)	5	0
	Dark nearly black clay	1	0
	Gray greasy clay	2	0
277	Gray to dark chocolate clay	2	0
	Chocolate to nearly black clay	4	0

2720
2722
2723

Glacial and Ravenscrag	0–30	0
2723, black plastic clay	2	0
2722, gray clay, purplish tint	4	0
White plastic, many iron concretions	4	0
2720, white sandy clay	20	0
Lead gray sandy clays (Estevan)	?	

	Ft.	In.
2742*		
Glacial and Ravenscrag	5–40	0
Yellowish shale (Ravenscrag)	6	0
Lignite	0	6
2742, bluish clay, dries gray	4	0
Unknown		

* From a test pit

	Ft.	In.
2769		
2770		
Glacial and Ravenscrag	15	0
Lignite	1	0
2770 Dark chocolate to purple	1	0
Lighter shade (Nodular iron concretions)	3	0
2769, grayish with purple tint (Nodular iron concretions)	6	0
Yellowish iron-stained gray	7	0
White plastic, fine-iron concretions	10	0
Lead gray sandy beds (Estevan)	?	

	Ft.	In.
2767		
Glacial and Ravenscrag	30	0
Lignite	2	0
Purplish plastic clay	2	0
Iron seam	0	10
Grayish plastic clay	8	0
2767 Black plastic clay	2	0
2767 Gray to dark chocolate clay	2	0
2767 Dark chocolate to black clay	1	0
Dark clay	3	0
Unknown		

Summary

The ball clays, the physical properties of which have been here described, differ both from the English and American ball clays in several respects, though their plasticity and working properties are the equivalent of the best clays of this type.

The water of plasticity of the Saskatchewan clays averages about 25% on the wet basis. This figure is somewhat lower than the normal for either American or English clays; it no doubt explains in a measure the lower drying shrinkage of the Saskatchewan clays and indicates the existence of a different structure.

The remarkably high strength in the raw state of the Saskatchewan clays is noteworthy. On comparison with figures given by Parmelee and McVay[12] it is to be observed that the three Saskatchewan clays of highest strength exceed the three strongest American and English clays by 26+%. Further, in a similar comparison with figures by Sortwell* the difference in favor of the Saskatchewan clays is 74+%. Therefore, in cases where high bonding power, strength in the raw or bisque state is desirable, the Saskatchewan clays are of much interest.

On the other hand they are more inclined to crack in drying than the standard clays of this type, a fact to be taken into consideration in determining the amount it is safe to use in a given body.

From reliable sources the firing shrinkage of ball clays in actual use at cone 8 is about 26%. The Saskatchewan clays here reported on, as

[12] *Jour. Amer. Ceram. Soc.*, **10** [8], 598–628 (1927).

* See reference 10, p. 364.

a rule, show a shrinkage lower than the above figure at the same temperature. This may be accounted for in part by different firing conditions.

The trend of the shrinkage curves of some of the Saskatchewan clays is quite different both from the English and American ball clays; the latter show at cone 8 a drop in absorption to about 5% while a number of the Saskatchewan clays remain somewhat more open at this cone.

FIG. 3.

Through a study of the volume shrinkage-porosity curves it is noticeable that the Saskatchewan clays have on the whole a lower shrinkage than either the American or English ball clays, the rate of change being more nearly that of the English clays. On the other hand the Saskatchewan clays, with one exception, show a higher porosity than the English clays between cones 6 and 12, and, in addition, there is a slight continuous change from cone to cone in the Saskatchewan clays where the English clays remain constant. In comparison with Tennessee ball clays the Saskatchewan clays show slightly lower porosity changes between cones 6 and 12, and materially less than those of the Kentucky clays.

It is to be noted among the Saskatchewan clays that eight of them are white or nearly white at cone 4 and of these three remain white at cone 8. Nine are light cream at cone 4 and of these seven remain of the same shade at cone 8. Thus, where a white body is desirable some of the Saskatchewan clays are of interest, and especially so in thin section ware requiring maximum strength in the raw. One difficulty is met with, however, through the presence of more or less dark specks due to some iron-bearing mineral. While traces were found in all samples, five of them have proven sufficiently free of speck to permit of their use in large quantities in the U. S. whiteware industry during the past three years. Further study with reference to the removal of the objectionable specks in the Saskatchewan clays is to be recommended.

FIG. 4.

The chemical analyses of the Saskatchewan clays indicate that they carry more free silica than the average English and American ball clays. Generally speaking the average pottery ball clay in the dry state fluctuates around 35% alumina content. The present clays, with one exception, carry from 28.8 to 29.3% of alumina.

Though the fusion points of ball clays may be of little interest to the manufacturer of whiteware, they were obtained in the present work for each of the clays and the findings have proved of interest in that eight of them have a P.C.E. of cone 32 or more. This quality, in connection with their high strength in the raw state, makes them worthy of study as bond clays for various lines of refractories.

The time required for the oxidation of ball clays is not normally of much importance, since in the manufacture of whiteware other body constituents are nearly always introduced, which open up the structure. Of the clays tested, however, 2723 is the only one which might lead to manufacturing difficulties in the firing of the ware.

Acknowledgments The work here presented has been made possible through the harmonious coöperation of the Department of Railways, Labour, and Industries of the Saskatchewan Government and the Ceramic Department of the University. The author desires to express his appreciation of the hearty support of T. M. Molloy, Deputy Minister, Department of Railways, Labour and Industries, throughout the entire work, also to S. Matthews for the efficient and laborious laboratory work carried out under his supervision. Acknowledgment is also made of the services of Jas. R. Craig, J. C. Worcester, W. H. Phipps, and others, extending over a period of two years. It is also a pleasure to mention A. V. Bleininger who gave helpful suggestions throughout the work, and for the supply of commercial whiteware glaze used in the glaze studies.

RELATION BETWEEN THE TEMPERATURE CURVE AND THE EXPANSION CURVE IN THE SETTING OF PLASTER[1]

By F. J. Williams and F. C. Westendick

ABSTRACT

The plan of the investigation was to determine the relation between the expansion curve and the temperature curve in the setting of plaster of Paris, which is manufactured by calcining gypsum at about 145°C in muffle or rotary cylinders. The setting of plaster results from the fact that when it is mixed with water the latter dissolves some of the hemihydrate which unites with the water to form the dihydrate. The first volume change is a contraction followed by expansion, due to the fact that the calcium-hemihydrate ($2CaSO_4$-H_2O) goes into solution, thus decreasing the volume. An equilibrium is reached when the solution is saturated and then the dihydrate ($CaSO_4$-H_2O) crystallizes out, causing expansion. Apparatus, methods of testing, data, calculations and curves are given.

Introduction

Plaster of Paris, which is the hemihydrate of calcium sulphate ($2CaSO_4$-H_2O), is manufactured in large quantities by calcining gypsum at about 145°C in muffles or rotary cylinders. When finely-ground material is mixed with about twice the theoretical amount of water required to convert it into gypsum, the dihydrate ($CaSO_4$-H_2O), it forms a mass which sets in a short time to a solid. Since the setting of plaster is accompanied by a slight expansion it makes plaster an invaluable article to the ceramist for molds. Whenever the plaster is used either to cast a mold or cast in a mold, the fact that it expands slightly thus filling all the cracks and crevices tends for a clear impression of the object desired to be reproduced.

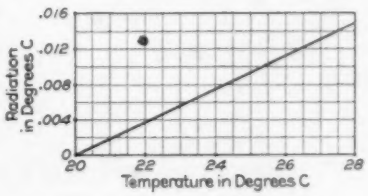

Fig. 1.—Radiation curve.

The setting of plaster of Paris results from the fact that when it is mixed with water the latter dissolves some of the hemihydrate, which unites with the water to form the dihydrate. Since the latter is less soluble than the former, it crystallizes from the solution, and more of the hemihydrate dissolves. This process continues, according to the law of the solubility product, constant until the plaster has been changed into a mass of interlocking crystals from which the excess water evaporates. If the plaster has been hard burned or "dead burned" it requires hours or days for this setting. In the case of ordinary plaster only a comparatively short time is required.

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[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Terra Cotta Division.) Received December 7, 1928.

In order that the plaster be of maximum modulus of rupture, it should be dried slowly at 65 °C or under after it has set. It has been determined experimentally that this is the highest temperature at which plaster can be conveniently dried for best results. A higher temperature seems to destroy the crystalline structure, thus weakening the plaster body.

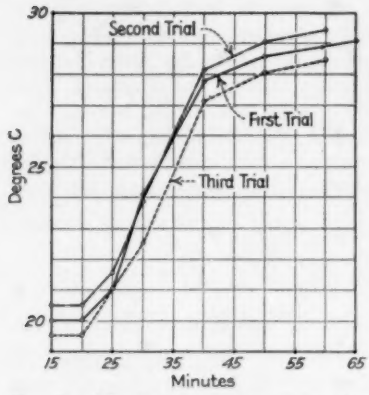

FIG. 2.—Time-temperature curves for setting of plaster.

There are several types of slow-setting plasters and hard-finish plasters on the market but these will not be discussed in this paper.

Plan of Investigation

The plan of this investigation was to determine the relation between the expansion curve and the temperature curve in the setting of plaster. Since there was so little information available on the subject the experiment was conducted with the ultimate aim of offering data and curves for future reference on the subjects of volume and temperature changes when a solution of calcium sulphate hemihydrate in water crystallizes out as calcium sulphate dihydrate.

Apparatus

The apparatus consisted of a testing box of wooden structure so constructed as to fit over a water bottle and give about $^1/_2$-inch clearance at the closest points. The wood used was $^3/_4$-inch oak material in order that there would be no elasticity in the sides of the box. The inside dimensions of the box were 8 by 10 by 3 inches. The two largest sides were fastened together with bolts while the rest of the joints were held with screws. These bolts, running through the narrow way of the box, made it possible to remove the two largest sides, and thus offer a means for removing the plaster after it had set. The water bottle was set in the top of the box in a hole cut to fit the neck of the bottle and the adjustment was sealed with sealing wax. The top of the box was equipped with a thermometer hole and a hole with also a sliding cover in which the plaster was poured. A hole was drilled in the stopper of the water bottle and a glass tube about four inches long was inserted. This was made water tight by

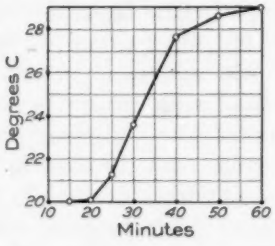

FIG. 3.—Time-temperature curve for setting of plaster.

means of sealing wax. Three inches of rubber tubing connected this to a burette. The burette was held in place vertically by a ringstand and a clamp. In order to afford free flow to the water from the bottle into the burette, the glass stopper portion was removed and the control furnished by a clamp on the rubber tubing joint between the bottle and burette.

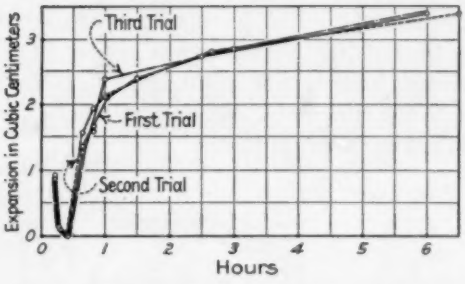

FIG. 4.—Time-expansion curves for setting of plaster.

Method of Conducting Test

The apparatus, as previously described, was assembled, after which 1250 cc. of water were poured in the water bottle and forced up into the burette until the reading was 30 or thereabout. This was held at that point by the pinchclamp on the rubber tube. A batch of plaster was mixed up in the ratio of one quart of water to $2^{3}/_{4}$ pounds of plaster. This was stirred well and just when the mix started to set it was poured into the box. Since the mix was quite fluid it filled all the corners as well as the rest of the box. A coat of sizing kept any plaster from adhering to the walls of the box. A sample of the liquid mix was kept out to see how the plaster was setting. As soon as the plaster started to solidify the pinchcock was released and the readings taken. These readings were taken every five minutes at first and then at longer intervals. When the test was finished the plaster was removed for the next run.

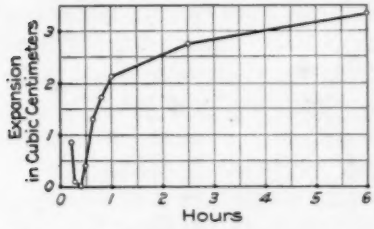

FIG. 5.—Time-expansion curve for setting of plaster.

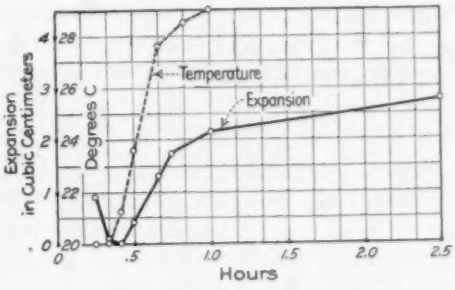

FIG. 6.—Comparison of temperature and expansion curves.

Data, Calculations, and Curves

A number of trials were run to test the apparatus and its manipulation before accurate results could be obtained. The data for these trials

will be omitted. The following three trials are the last three. They check within experimental range.

As soon as the plaster was mixed, time was recorded. This is given in hours and minutes. The burette reading was recorded directly in cubic centimeters. The temperature was recorded at the same time and the correction for radiation was made. The correction and the corrected temperature appear in the last two columns.

When the plaster had been mixed 10 minutes it was poured and readings taken as shown in tables.

FIRST TRIAL

Time	Burette reading	Temperature	Radiation correction	Temperature corrected	Expansion in cc.
0:15	37.20	20.00	5 × 0.000–0.000	20.00	−0.90
0:20	38.00	20.05	5 × 0.000–0.000	20.05	−0.10
0:25	38.10	21.00	5 × 0.001–0.005	21.01	0.00
0:30	37.70	24.00	5 × 0.005–0.025	24.03	0.40
0:40	36.75	28.30	10 × 0.011–0.110	27.79	1.35
0:50	36.45	28.30	10 × 0.015–0.150	28.59	1.65
1:05	36.00	28.50	15 × 0.016–0.160	29.03	2.10
1:30	35.70	Drop			2.40
2:30	35.35				2.75
6:00	34.70				3.40

SECOND TRIAL

Time	Burette reading	Temperature	Radiation correction	Temperature corrected	Expansion in cc.
0:15	33.10	20.50	5 × 0.000–0.00	20.50	−0.85
0:20	33.90	20.50	5 × 0.000–0.00	20.50	−0.05
0:25	33.95	21.50	5 × 0.002–0.01	21.51	0.00
0:30	33.55	23.75	5 × 0.005–0.03	23.79	0.40
0:35	32.80	27.00	5 × 0.010–0.05	27.09	1.15
0:40	32.40	28.00	5 × 0.014–0.07	28.16	1.55
0:50	32.00	28.70	10 × 0.016–0.16	29.02	1.95
1:00	31.80	29.00	10 × 0.017–0.17	29.49	2.15
2:40	31.10	Drop			2.85
6:30	30.60				3.35

THIRD TRIAL

Time	Burette reading	Temperature	Radiation correction	Temperature corrected	Expansion in cc.
0:15	36.85	19.50	5 × 0.000–0.00	19.50	−0.95
0:20	37.70	19.55	5 × 0.000–0.00	19.55	−0.10
0:25	37.80	21.00	5 × 0.002–0.01	21.01	0.00
0:30	37.40	22.50	5 × 0.004–0.02	22.53	0.40
0:35	36.80	25.50	5 × 0.008–0.04	25.57	1.00
0:40	36.50	27.00	5 × 0.012–0.06	27.13	1.30
0:50	36.20	27.75	10 × 0.014–0.14	28.02	1.60
1:00	35.40	28.00	10 × 0.015–0.15	28.42	2.40
3:00	35.00	Drop			2.80
5:00	34.60				3.20
6:00	34.40				3.40

SUMMARY OF TRIALS

Trial	Expansion (cc.)	Temperature change (°C)
1	3.40	9.03
2	3.35	8.99
3	3.40	8.92
Average	3.38	8.98

Conclusion

From the foregoing data and curves, one may conclude that the first volume change in the setting of plaster is a contraction followed by expansion. This is probably due to the fact that the calcium-hemihydrate ($2CaSO_4$-H_2O) is going into solution, thus decreasing the volume. An equilibrium, however, is reached when the solution is saturated in respect to the hemihydrate, and then the dihydrate ($CaSO_4$-H_2O) starts to crystallize out. This crystallization causes expansion, thus changing the direction of the curve. The first contraction allows the fluid plaster to settle and fill all the cracks and irregularities in the surface being cast and then to expand and fill them tightly.

The heat evolved is primarily a heat of solution of the hemihydrate. The crystallization of the dihydrate absorbs some of the heat produced. This is shown by Fig. 1. While the expansion curve is dropping showing a solution of the hemihydrate, the temperature curve is rising. The temperature curve reaches a maximum when the hemihydrate is all in solution but the expansion curve continues to go up due to the crystallization of the dihydrate.

The temperature readings were corrected to radiation from radiation curve. The error due to radiation is too great to be neglected so it was necessary to take data for a radiation curve and correct for radiation.

The expansion of the water was so small over the temperature range used that a correction for expansion could be omitted.

Figure 1 is the radiation curve just mentioned. It is a standard radiation curve. Radiation at room temperature (20°C) was zero and radiation at 28°C was determined by readings every 10 minutes when the apparatus was cooling at 28°C.

Figure 2 has a rise in temperature plotted against time. All the three trials are on the same axis. Figure 3 is an average of the curve in Fig. 2. These curves are not corrected to amount since curves are only relative and depend on the units taken.

Figure 4 shows the ratio between time and expansion. Again the curves are not corrected to amounts since the curves are only relative and correction is not necessary since the slope of the curve would not be changed. Figure 5 gives an average of the three curves in Fig. 4.

Figure 6 contains the average time-temperature curve and the average time-expansion curve on the same axis for comparison.

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Abrasives

Precision grinding in magneto manufacturing. B. K. PRICE. *Abrasive Ind.*, **10** [3], 89 (1929).—Many and closely conducted grinding operations are involved in the manufacture of magnetos. Not only are there a large variety of parts to be ground, but of many parts a number of operations and limits of 0.0005-inch are not infrequent. Work conducted at the plant of the Splitdorf-Bethlehem Electrical Co., Newark, N. J., furnishes an excellent illustration of precision grinding as employed in this industry. E.P.R.

Disk grinding. ANON. *Abrasive Ind.*, **10** [3], 93 (1929).—In modern production schedules, the object is to finish various parts to predetermined limits in as few operations as possible. Today with modern abrasives and bonds, the disk grinder is an intensive production unit. Perhaps the greatest advantage to be derived from disk grinding is the fact that the abrasive agent starts at the outer surface and works in. Thus, finish allowances can be reduced materially. E.P.R.

Crankshaft grinding. FRED B. JACOBS. *Abrasive Ind.*, **10** [3], 95 (1929)—The work is prosecuted on a high production basis by using machines of special design and abrasive wheels provided especially for this work. The accompanying article illustrates and describes operations carried on at the plant of the Atlas Mfg. Co., Fostoria, Ohio, a pioneer in the manufacture of this product. E.P.R.

Motor rebuilder must adopt intensive production methods. WALTER TREFZ. *Abrasive Ind.*, **10** [3], 97 (1929). E.P.R.

Labor saving methods revolutionize cylinder finishing practice. C. G. WILLIAMS. *Abrasive Ind.*, **10** [3], 99 (1929).—One of the most important processes in the production of the automobile is the finishing of the cylinders. E.P.R.

Smooth undercoats necessary in refinishing automobiles. ANON. *Abrasive Ind.*, **10** [3], 105 (1929). E.P.R.

Grinding Diesel engine parts. ANON. *Abrasive Ind.*, **10** [3], 106 (1929).—The bulk of external grinding is done on Norton machines, which for most work are equipped with alundum wheels. E.P.R.

Reclaiming locomotive parts by grinding. HERBERT R. SIMONDS. *Abrasive Ind.*, **10** [3], 108 (1929).—By building up worn parts with welding and then grinding and machining to size, the Maine Central Railroad reclaims much material which would otherwise be scrapped. Shops at Waterville, Me., keep equipment up-to-date. E.P.R.

Cylinder grinder scope increases. ANON. *Abrasive Ind.*, **10** [3], 110 (1929).—At the annual stockholders meeting of the Hutto Engineering Co., Inc., Detroit, held recently, it was announced that the company's net profit for the year, was approximately $122,000. The company is engaged in the manufacture and sale of the Hutto grinder which is covered by basic patents. The device is used for the grinding of all

types of cylinders where accuracy and precision are required. Automotive business for production grinding and for service work now accounts for about 85% of the company's output. E.P.R.

Chromium plating. BERNARD JEFFS. *Abrasive Ind.*, **10** [3], 113 (1929).—J. discusses the progress made in chromium plating and gives practical data for the guidance of the plater. He points out that practical chromium plating operations are beset with many serious difficulties and stresses the fact that chromium will not replace nickel in industrial electroplating. E.P.R.

Drilling chinaware. ANON. *Abrasive Ind.*, **10** [3], 115 (1929).—The present method of doing this work is to use a metal cutting drill. If the drill is kept wet with turpentine, good results can be obtained. It is true that an abrasive pencil used with a flexible shaft outfit can be used for drilling these holes. It is almost impossible, however, to get a flexible shaft outfit to generate the speed to drive the abrasive pencil at the surface travel necessary to make it cut effectively. The entire matter is one of experimentation. The abrasive pencil method may be used provided enough speed can be obtained to drive the pencil fast enough to impart a peripheral travel of at least 4000 feet per minute. E.P.R.

Coated abrasive paper. ANON. *Abrasive Ind.*, **10** [3], 118 (1929); see U. S. 1,687,453, *Ceram. Abs.*, **7** [12], 804 (1928). E.P.R.

Chrome plate rouge. ANON. *Abrasive Ind.*, **10** [3], 123 (1929).—The E. Reed Burns & Sons, Inc., founded 41 years ago, with plants at Brooklyn, New York, Cleveland, and Chicago, announces the production of a new rouge for use on chrome plate. This material is sold under the trade name "Colorchrome," and is made in green and white. The oxide is carefully checked to prevent scratching, and the grease bond is one that is completely saponifiable. E.P.R.

Plain grinding machine. ANON. *Abrasive Ind.*, **10** [3], 124 (1929).—The Brown & Sharpe Mfg. Co., Providence, R. I., has recently announced the addition of the No. 35 plain grinding machine to its line of new plain grinders. E.P.R.

Surface grinder. ANON. *Abrasive Ind.*, **10** [3], 125 (1929).—A motor-driven surface grinder was recently developed by the Diamond Machine Co., Providence, R. I. It will handle work 24 **x** 12 **x** 12 in., under a 12-in. wheel. The bed and column are cast in one piece and are internally braced for extra rigidity. The broad vee and flat ways are accurately tested for parallel alignment. E.P.R.

Heavy duty grinder. ANON. *Abrasive Ind.*, **10** [3], 125 (1929).—A floor grinding machine was designed recently by the Norton Co., Worcester, Mass. It is a combination high-speed floor stand that can be equipped with hoods for using either 24- or 30-in. diameter wheels. The design hinges around the use of a motor mounted in the base. This makes it possible to use any standard alternating or direct-current motor so that repairs when necessary can be easily and quickly made. Overlapping steel boiler-heads that comply with the safety code for wheels operated at 9000 surface ft. per min. are used for the wheel protection guards. The machine is compact, massive, and of simple design. The base is heavy cast iron covered so as to allow plenty of foot room for the operators. E.P.R.

Polishing lathe. ANON. *Abrasive Ind.*, **10** [3], 126 (1929).—A new single-spindle polishing lathe has just been developed by the Gardner Machine Co., Beloit, Wis. It embodies a number of advantages such as the ability to obtain any desired spindle speed with alternating current motor drive, the use of a V-type multiple belt drive, great rigidity, compactness, and convenience of operation. E.P.R.

Wheel for alloy steel grinding. ANON. *Abrasive Ind.*, **10** [3], 126 (1929).—The Detroit-Star Grinding Wheel Co., Detroit, are introducing a special wheel for grinding the new alloy steel known to the trade under the names of carboloy, Strauss metal,

diamondite, and widia. The new development is the result of extensive laboratory research and practical experimentation at the Detroit-Star plant to produce a wheel to grind the steel satisfactorily. E.P.R.

Weber machine grinds and polishes edges of flat glass automatically. ANON. *Amer. Glass Rev.*, **48** [21], 23–24 (1929).—The Weber machine is automatic. The glass is edged and polished in four stations. Three are for grinding the flat edge into a rounded edge and the fourth is for polishing with pumice. The resultant edge, whether on crystal sheet or plate glass, is smooth to the touch and accurately finished along its entire length. Any size of flat glass can be handled. The machine has four speeds. The choice of speed depends upon the number of pieces being ground at one time and the size and weight of the sheet. Six pieces are put in position at one end by one man and are taken away at the other end by another with the machine working at full speed. As only one edge is ground at one time it is necessary to return the glass to the starting point if other edges are to be ground off and polished. E.P.R.

Remove end-play on bench grinder. P. GATES. *Mech. World*, **85** [2193], 33 (1929).—In the design of high-speed grinding machines the question of spindle adjustment receives considerable thought. When end-play develops, unless care is taken, expensive tools may be spoiled. A useful and simple method of overcoming the difficulty is the introduction of a spring collar. When in position no movement of the spindle should be felt when grinding, but when stationary one should be able to move it with reasonable pressure. The spring collar used by the writer was "sandwiched" between the boss of the driven pulley and the cast-iron bearing cover. E.P.R.

Garnet for abrasive purposes. V. L. EARDLEY-WILMOT. *Eng. Min. Jour.*, **124** [3], 96 (1927); see *Ceram. Abs.*, **8** [1], 6 (1929). A.J.M.

PATENTS

Grinding machine. EDWARD B. AND RALPH D. GARDNER, AND JOHN NIELSEN. U. S. 17,223, Feb. 26, 1929. (Reissue.) In a grinding machine the combination of a grinding tool, a rotatable indexing wheel, a work carrier slidably mounted on the wheel, means for holding the wheel against rotation except when the carrier is disposed in one of its extreme positions, the means being adapted to limit the indexing movement of the carrier, and means for reciprocating the carrier in indexed position.

Grinding machine. HARRY G. MILLER. U. S. 1,702,267, Feb. 19, 1929. (1) In a machine for grinding stemmed valves true to the axes of their stems, the combination with a grinding wheel, of a work support having stem centering means operative upon the stem independently of the valve supporting end thereof and at widely separated points, one of which is in proximity to the valve, the supporting means being adapted to permit instant removal and replacement by longitudinal and lateral manipulation, and a driving head adapted to engage and rotate a valve about the axis of its stem without lateral displacement pressure. (2) In a valve grinding machine the combination with the grinding wheel, of a carriage for the valve, the carriage being provided with head- and tail-stock members for positioning and supporting the valve in the position to be ground, the tail-stock member having a resilient plug adapted to act on the end of the valve stem, and the head-stock member having a stationary spindle adapted to engage the center of the valve and a rotary device carrying resilient pins adapted to engage the valve on opposite sides of its center, the stationary spindle passing through a central opening formed in the rotary device.

Hob-grinding machine. CARL G. OLSON. U. S. 1,702,520, Feb. 19, 1929. A hob-grinding machine having a hobspindle, a reversible grinder head for holding the grinding wheel in contact with the hob, and means for rotating the hob and simultaneously causing relative travel between the hob and the grinding wheel in accordance with the lead of the hob and a relative bodily movement radially of the hob in accordance

with the relief in the hob teeth, the grinder head being pivoted about an axis approximately perpendicular to a plane whose position is determined substantially by the hob axis and the grinding wheel axis.

Polishing and grinding material. BERTRAND SZILARD. U. S. 1,704,308, March 5, 1929. The process of producing a polishing and grinding material, comprising the steps of mixing titanium oxide and another titanium salt, both in unroasted condition; preparing a colloidal solution from such mixture; and precipitating the colloidal solution to obtain an extremely fine powder.

Hob grinder. CHARLES J. IRWIN. U. S. 1,704,833, March 12, 1929. A hob grinder having a grinder, a hub spindle which is rotatable and axially movable, a gear wheel fastened to the hob spindle and traveling therewith, a wide-face pinion meshing with the gear for rotating it, a lead screw integral with the hob spindle for moving it axially, two bearings, one for the hob spindle and the other for the lead screw, and means for rocking the bearings to move the hob toward and from the grinder in accordance with the relief on the hob teeth.

Wood-grinding machine. ROBERT E. READ. U. S. 1,705,097, March 12, 1929. In a wood-grinding machine, the combination of a grinder, a pocket for holding wood to be ground, wood feeding means adapted to engage the wood in the pocket to force the same against the grinder, a plurality of driving devices acting to apply driving forces to the feeding means, and controlling means operative automatically to bring the driving devices into action on the feeding means consecutively.

Grinding machine. JAMES N. HEALD AND RAY D. HUBBELL. U. S. 1,705,114, March 12, 1929. In apparatus of the class described, a reciprocatory table, a member shiftable in opposite directions to procure the reversals in the movement of the table, adjustable stops carried by the table for engaging and shifting the member, one of the stops being releasable so as to be movable longitudinally to temporarily increase the travel of the table in one direction, the stop ultimately acting to reverse the table, and means for automatically restoring the stop to normal position.

Grinding machinery. GEORGE W. BINNS. U. S. 1,705,230, March 12, 1929. A grinding machine including a pair of spaced rotary wheels having their operative surfaces moving at different speeds and in opposite directions, and a third rotary member peripherally projecting into the throat between the wheels for supporting work in the throat against the thrust of one of the pair of wheels during grinding.

Abrasive sheet material. C. KLINGSPOR. Brit. 302,430, Feb. 6, 1929. Waterproof abrasive paper, etc., consists of a paper backing to which the abrasive powder is secured by an adhesive comprising animal glue and a phenol-formaldehyde condensation product, the adhesive being hardened and rendered waterproof by heating to a temperature not exceeding 150°C. The condensation product used is one obtained in the early stages of the condensing process, and is diluted with alcohol; the glue is dissolved in water, and glycerine and linseed oil or other oil may be added, the adhesive consisting of the mixture of the foregoing constituents. A second coating of adhesive may be applied after application of the abrasive; this coating may consist only of the condensation product, with or without alcohol. The paper, etc., may be impregnated with linseed oil and dried before application of the adhesive.

Steady rests for grinding machines. H. WADE. Brit. 302,443, Feb. 6, 1929. A steady rest for a machine for grinding cylindrical work consists of a frame having pivoted thereon a work-engaging shoe, and a shoe slidable therein.

Surface grinding. LUMSDEN MACHINE CO., LTD., AND E. G. BLAKE. Brit. 302,676, Feb. 13, 1929. In a surface grinding machine, the surface to be ground is prepared for grinding by producing therein closely spaced scorings, cuts, or indentations. In machines wherein relative reciprocation of the wheel and work takes place, a tool is placed

on each side of the wheel; a series of tools in staggered succession may be used. In place of the serrated tool, a knurling roller, or a percussive tool may be used; the cuts may be rectilinear, circular, or may intersect. The cuts may be deeper than the grinding cut, and produced in advance of every other grinding cut. The cuts may be produced in a separate machine.

Grinding wheels. C. KRUG. Brit. 302,689, Feb. 13, 1929. In a grinding wheel consisting of a carrier disk to which are detachably secured a number of grinding bodies, the bodies each consist of a flanged thin sheet metal mounting having tongues pressed up therefrom, the abrasive body being molded, while in a soft state, in the mounting so that the tongues are embedded in the body; or cement may be employed for securing the body to the mounting. The bodies are each secured to the carrier by a central hollow flanged bolt and a nut. An elastic layer may be inserted between the mountings and the carrier. The blocks may be of cylindrical form, the sides being flattened or may be of solid sector shape, or may be of sector shape with channels cut therein.

Art

Ancient Ithaca. WM. DÖRPFELD. *Art and Arch.*, **27** [2], 51–57 (1929).—On the island of Leucas, thought to be ancient Ithaca, west of Greece, were found under a layer of sand and gravel from 3 to 5 meters thick, innumerable fragments of monochrome, prehistoric pottery with a few fragments of Mycenean type. Graves there yielded unpainted Achaean pottery. Illustrated. E.B.H.

Tile as a decorative art. LEON V. SOLON. *Arts and Dec.*, **30** [5], 82–84 (1929).—Tile making is undergoing many radical changes both in treatment and in manner of application. Interesting developments will be presented to the public during the Co-operative Exhibition of Industrial Arts opening in March at the Metropolitan Museum. A new wall tile will be shown achieving a wonderful play of color over embossed surfaces. There will be a spectacular tile fountain in which the source of water instead of being a feature of the design has been concealed. The water runs over surfaces oddly broken up by projecting tile producing a shimmering rippled surface. New and original glazes and designs belong no more definitely to the modern and modernistic settings than do those that have waited 600 or 700 years to find such harmonious surroundings. Roof tile in new blends of color, brilliant tile borders for doorways, outside wall panels, and fountains are being made. E.B.H.

The collector. ANON. *Int. Studio*, **92** [381], 56 (1929).—Illustration of Persian blue lustered vase from Rhages, 13th Century, with polo players and other figures in high relief. E.B.H.

Garden pottery. ANON. *Int. Studio*, **92** [381], 60 (1929).—Charming ceramic gardens associated with the names of the celebrated landscape architect of Spain, Nicholas MaRubio, the illustrious potter Artigas, and the modern painter Raoul Dufy, and destined to make their bow at the Arden Galleries in February have surpassed Japanese rock gardens. E.B.H.

Modern art trends in glassware. ANON. *Amer. Glass Rev.*, **48** [22], 15–16 (1929).—For the last year the U. S. has been overwhelmed with modern art and the glassware trade has not escaped. More progress has been made in New York than in any other section of the country, in developing modern art. E.P.R.

Modernistic glass. ANON. *Nat. Glass Budget*, **44** [37], 3 (1929).—The Kopp Glass, Inc., has made pronounced progress in further developing railway, marine, and highway lenses and other kinds of glass, as well as in the production of modernistic lighting glassware. E.P.R.

Lighting glassware. ANON. *Nat. Glass Budget*, **44** [37], 3 (1929).—The Jeanette

Shade and Novelty Co., Jeanette, Pa., is exclusive in the manufacture of lighting glassware. E.P.R.

Russian pottery and china. ANON. *Pottery, Glass, and Brass Salesman*, **39** [2], 31–32 (1929).—Russia, during the past decade has been a negligible factor in the American pottery trade, but resumption of trade relations with Soviet Russia is bound to affect the china, glassware, and artware trade of America to a certain degree, and for this reason the china and earthenware sections at the Russian exposition may profitably be visited by members of the trade who desire advance knowledge of the commercial potentialities of the Russian wares. The ceramic collection has been wisely chosen so that a variety of the finest specimens of china are shown, as well as a large assortment of crude peasant earthenware. The peasant earthenware on display at the exposition serve to tell a more significant story of Russia than does the chinaware made in the city works, for the greater portion of the Russian population is rural, and the peasants are now being tutored by government institutions in the creation of better wares. Earthenware products are made mainly in Oposhne Palchav, a small village in the Ukraine. All these products are made by hand on an earthenware form; only an insignificant number are cast in plaster of Paris forms. The baking is done in a dirt hole surrounded by brick, except in the coöperative trade school, where due to more favorable conditions it is done in kilns. The primitive earth-hole kilns belong to the type of simple furnaces that have no air current; they are built so deeply in the ground that the heat gets lost in drying up the humidity of the environment. E.P.R.

Great names in the history of English glass. IX. Bowles. F. BUCKLEY. *Glass*, **5** [12], 540 (1928).—The family of Bowles was noted for its connection with the manufacture of excellent Crown window glass. John Bowles was the inventor of the famous Ratcliff Crown Glass. The Bowles were also prominent in the manufacture of enamel glass. For preceding abstracts see *Ceram. Abs.*, **8** [4], (1929). A.J.M.

Paleolithic pottery. J. P. MOIR. *Nature*, **123**, 165 (1929).—Fragments of pottery have been found in the cultural layer immediately overlying that of the famous Neanderthal skeletons, in upper Paleolithic deposits in Belgium, and near Ipswich. Pottery has been found associated with flint implements of the upper Mousterian or lower Aurignacian forms. C.R.A.

Colored glasses. W. M. HAMPTON. *Glass Ind.*, **10** [3], 65–67 (1929); see also *Ceram. Abs.*, **7** [6], 342; [10], 659 (1928). E.J.V.

Early Staffordshire earthenware. ALFRED J. CADDIE. *Pottery Gaz.*, **54**, [621], 453 (1929).—In the second half of the 17th Century the ceramic productions of the Staffordshire pottery district were crude. Decoration was simply a "slip" (or liquid clay), the potter evolving his design without patterns making portraits of kings and queens, heraldic animals, conventional flowers, etc., a somewhat striking feature being the bold trellis-work borders. The pieces were then glazed by applying powdered lead ore, and firing. About the year 1609, John Philip Elers established a pot works at Bradwell Wood, near Stoke-on-Trent using local clay and making a fine red ware of excellent texture, very far in advance of the slip-decorated production of the natives. The quaint ornamentations in relief were stamped by means of metal stamps, a simple mechanical device which was the forerunner of the pitcher molds utilized by Wedgwood and others. Elers assumedly introduced salt glazing. Another quaint variety was the "scratched" ware, the process being to first engrave a simple design with some crude implement and then dust in powdered Zaffre, which on firing gave a pleasing blue tone. In the painted or enameled salt-glazed ware a great amount of Oriental influence was apparent, as also was the case with the Bow and Chelsea porcelain of the same period. Many of the designs were of quite an ambitious character. Tremendous strides were made in the potter's art during a period of roughly fifty years. Gradually

a good earthenware body was produced, which probably reached its height in the cream colored earthenware of Whieldon and Wedgwood. The principal varieties were "solid agate" ware, "tortoiseshell," "cauliflower," and "pineapple," the application of colored glazes being a very striking feature. E.J.V.

First Maya mosaic ever found. EARL MORRIS. *Illust. London News* **174,** 127 (1929).—The Warriors' Temple at Chichen Itza, Yucatan, has been excavated and restored by an expedition from the Carnegie Institute of Washington. A plaque of 2500 pieces of turquoise, regarded as among the finest examples of aboriginal American art, was discovered under the floor of a buried temple within the Warriors' Temple. Illustrated. H.H.S.

Discoveries at Pompeii. F. HALBHERR. *Illust. London News,* **174,** 218–19 (1929).—The new scientific methods of excavation adopted at Pompeii since the war have been extraordinarily successful. The latest discoveries are in the Street of Abundance, a quarter of houses of two and three stories. Illustrated. H.H.S.

Silician votive vases of 2000 B.C. P. MARCONI. *Morning Post,* Feb. 26, 1929.—The Dept. of Antiquities in Sicily, of which M. is director, has unearthed three complete votive altars to the goddesses Demeter and Persephone at Girgenti (Agrigentum). The relics definitely belong to the 6th Century B.C., and hence furnish data on the study of Hellenic culture in Sicily. The altars are rich in votive objects, lamps, bowls, cups, vases fired and unfired, clay models of heads, and innumerable statuettes. H.H.S.

Excavation of the Moon-God's temple at Ur. ANON. *Morning Post,* Feb. 26, 1929.—The joint expedition of the Univ. of Pa. and British Museums has excavated the cemetery and temple of Nannar, the Moon-God. One of the best finds is a mosaic plaque in lapis lazuli. H.H.S.

Early Chinese celadon and porcelain. ANON. *Morning Post,* Feb. 26, 1929.—The Bluett galleries in London have brought together a remarkable collection of Chinese ware ranging in date from the Chou period (1122 to 256 B.C.) to the 17th and 18th Centuries A.D. Particularly interesting are the pre- T'ang pieces, which fill a gap in our knowledge of the era between the Han (206 B.C. to 220 A.D.) and T'ang (618 to 907 A.D.) periods. The exhibit also includes Sung ware, celadon vases and saucers, and Ming porcelain dishes. H.H.S.

BOOKS

Color and Color Theories. CHRISTINE LADD-FRANKLIN. Routledge, Kegan Paul and Co., London (1929). Price 12*s* 6*d*.—A discussion of the theories of color sensation, such as those of Hering and of Helmholtz, leading to L.'s own development theory. Illustrated. H.H.S.

The Magic Land of the Maya. W. L. PUXLEY. Allen and Unwin, London, 1929. Price 12*s* 6*d*. H.H.S.

Discoveries and Adventures in Central America. THOMAS GANN. Duckworth & Co., London (1929). Price one guinea.—Inscriptions and pottery found at Chumucha indicate that the Maya originated from the Archaic civilization which occupied the tableland from Mexico to Peru 3000 B.C. A branch of this people reached the coast near Vera Cruz 1000 B.C. and thence migrated southward to Honduras. Reviewed in *Illust. London News,* **174,** 264 (1929). H.H.S.

The Sumerians. C. LEONARD WOOLLEY. Oxford Univ. Press and Humphrey Milford, London (1929). Price 6*s*.—W. is leader of the joint expedition to Mesopotamia from the Museum of the Univ. of Pennsylvania and the British Museum. The objects found show that by 3500 B.C. the Sumerians had reached a high level of culture, and may be considered the forerunners of Egypt, Crete, and Greece. Reviewed in *Illust. London News,* **174,** 264 (1929). H.H.S.

PATENTS

Design for cover of dish. LUCIEN ANDUZE. U. S. 77,722, Feb. 19, 1929.
Design for covered dish. LUCIEN ANDUZE. U. S. 77,723, Feb. 19, 1929.
Design for plate. FREDERICK H. RHEAD. U. S. 77,912, March 5, 1929.
Design for plate. MAX J. PALM. U. S. 77,980, March 12, 1929.
Design for glass tumbler. DAVID FISHER. U. S. 77,759, Feb. 19, 1929.
Design for tumbler. IRA H. FREESE. U. S. 77,760, Feb. 19, 1929.
Design for goblet. WILLIAM H. MAGEE. U. S. 77,785, Feb. 19, 1929.
Designs for goblets. GEORGE DOUGHERTY. U. S. 77,942–44, March 12, 1929.
Design for goblet. ALFRED B. GUNTHEL. U. S. 77,952, March 12, 1929.
Design for tumbler. ROBERT J. BEATTY. U. S. 77,873, March 5, 1929.
Design for bottle. ISIDORE BAROUH. U. S. 77,727, Feb. 19, 1929.
Design for bottle. NICHOLAS N. COROTNEFF. U. S. 77,742, Feb. 19, 1929.
Design for bottle. JEAN W. BICKS. U. S. 77,805, Feb. 26, 1929.
Design for shingle. CHARLES J. MELBY. U. S. 77,786, Feb. 19, 1929.
Design for lavatory. GEORGE BRAIN. U. S. 77,877, March 5, 1929.
Shade for lighting fixture. REUBEN HALEY. U. S. 77,898, March 5, 1929.
Design for bathtub. WALLACE SELLIGMAN. U. S. 77,917, March 5, 1929.
Design for washstand. CARRIE G. BURBANK. U. S. 77,934, March 12, 1929.
Design for lamp standard. NICHOLAS KOPP. U. S. 77,966, March 12, 1929.
Design for candlestick holder. ROBERT E. MCELDOWNEY. U. S. 77,971, March 12, 1929.

Ceramic ware. CERAMIC PATENT HOLDINGS, LTD., AND J. W. MELLOR. Brit. 302,519, Feb. 13, 1929. In order that unglazed ceramic ware may be fired at lower temperatures than usual, a flux composed of an alkaline silicate or of a borate of an alkaline earth metal, including magnesium, or of a mixture of these, is added to the usual body composition in proportions of from 2 to 5%. The temperatures required for firing corresponds to that of the glost oven.

Frosting glass. ELEKTRISCHE GLÜHLAMPENFABRIK WATT A.-G. Brit. 302,582, Feb. 13, 1929. Relates to the process of frosting the inside of electric lamp bulbs and other hollow glass bodies, in which, after a 1st etching, a 2nd etching operation with a weaker etching medium is performed to round off the sharp edges formed during the 1st etching operation, and consists in the employment, for the 1st etching operation, of an etching agent from which the weaker etching medium can be evolved, *e.g.*, by hydrolysis or dissociation, during or directly after the first etching operation. A suitable agent consists of a mixture of ammonium hydrogen fluoride, calcium chloride, water, hydrofluoric acid, and barium sulphate in stated proportions. External heat may be applied to assist the reaction.

Cement, Lime, and Plaster

Determination of free lime in Portland cement. H. H. STEINOUR AND HUBERT WOODS. *Rock Prod.*, **32** [4], 74 (1929). F.P.H.

Changing the properties of Portland cement by artificial admixtures. ANON. *Rock Prod.*, **32** [4], 75–76 (1929). F.P.H.

Chemical reaction between trass and lime. A. STEOPOE. *Tonind. Ztg.*, **52** [80], 1609–12 (1928); *Rock Prod.*, **32** [5], 78 (1929).—S. presents his results in tables and diagrams for determining those quantities of the constituents of four German trasses, which are disintegrated by lime and enter into reaction with it, under the same conditions that these reactions take place in a normal hardening of trass mortar. Florentin's method (*Chem. et Ind.*, **17**, pp. 996–98) for the determination of cement in mortar and concrete was found to be exact and scientifically accurate, according to which 1 g. of

powdered mortar is weighed in a "boat" and gradually added (during 3 min.) to 60 cc. of cold HCl of 1.12 density, which was in a 250-cu. cm. cup cooled with water; after a pause of 10 min. the solution was filtered over a 12-cm. filter moistened with a few drops of HCl, and thoroughly washed with hot water; in the filtered liquid the silicic acid and the trioxide was determined in customary manner. S. based the values given in his tables upon the dried trass material; and the percentage of these proportions was calculated from the chemical composition of the trass and the mortar. Thus, S. first determined the loss on drying and the content of silicic acid and trioxide of the samples of trass, dried the mortar considerably upon a blast and placed it for the night in HCl 1.12, after which the easily soluble constituents were determined by Florentin's method. F.P.H.

Tests on crushed stone. A. T. GOLDBECK. *Pit and Quarry*, **17** [9], 53–60 (1929).—The investigations for which reports are made are (1) percentage of voids in stone as affected by gradation; (2) effect of dust-coated stone on concrete; (3) effects of different coarse aggregates on the strength of concrete; (4) cementation value of stone screenings. Description of samples, methods of test procedure, results and conclusions are given in detail. For the first investigation, grading No. 46 composed of 50% of $^1/_8$- to $^3/_4$-in. size and 50% of $1^1/_2$- to $2^1/_2$-in. size gave the lowest percentage of voids. Results of (2) show (*a*) the decrease in modulus of rupture due to the dust is from 1 to 1.5% for each increase of 1% in dust; and (*b*) the decrease in crushing strength is from 0 to 2% for each increase of 1% in dust up to the limit of 5.7% of dust used in the tests. When it is considered that the actual percentage of dust even in badly coated stone is small, and probably does not exceed 1.5%, the indications are that the decrease in strength is a negligible factor which is far over-shadowed by the unavoidable variations which obtain in the manufacture of concrete from day to day. Results of (3) showed that in all cases the stone concrete exceeded its competing gravel in cross-breaking strength and in all cases but one, the crushing strength of the stone concrete exceeded that of the gravel concrete. Results of (4) showed that the finer the screenings, the higher became the cementing value. Tables, photographs, and curves show the results of each investigation. Other investigations under way in the laboratory include studies of the sodium sulphate test for soundness as compared with the freezing and thawing test and the boiling test; and wear tests on concrete and on deleterious substances. R.G.E.

Laboratory tests on crushed stone. H. S. MATTIMORE. *Pit and Quarry*, **17** [9], 82–85 (1929).—M. discusses test results and conclusions of Goldbeck's four investigations (see preceding abstract) and does not fully agree with the findings. R.G.E.

New Prestolith Velo plant. W. E. TRAUFFER. *Pit and Quarry*, **17** [10], 45–56 (1929).—The Missouri Portland Cement Co. of St. Louis, recently completed and put into operation a new and modern plant at Prospect Hill, just within the city limits of St. Louis. This plant manufactures "Prestolith" Velo high early strength cement. Exhaustive tests at several laboratories have shown that this cement takes both its initial and final sets in about the same time that standard gray Portland cement takes its initial and final sets but after the set is completed it hardens much more rapidly. R.G.E.

Modern kiln design. E. L. JOHNSON. *Pit and Quarry*, **17** [10], 74–76 (1929).—J. refers to lime kilns but many of his statements apply equally to vertical cement kilns, magnesite kilns, plaster kilns, and shrunk dolomite kilns. Three types of kilns are discussed: (1) mixed feed vertical shaft kilns; (2) gas fired vertical shaft kilns; (3) rotary kilns. Aside from planning a kiln which will give a first-class lime, to meet requirement of present-day industrial conditions (1) the capital cost of the plant must be as low as possible, compatible with good lime; (2) fuel consumption must be very low; (3) maintenance cost of the kiln after erection must be reduced to a minimum; (4)

provision must be made for labor-saving devices to be included as far as is compatible with cost, in order that labor may be dispensed with and the cost of the product reduced to a minimum. Fuel economy, thermal efficiency, heat insulation, kiln construction, and size are discussed. R.G.E.

Future of the gypsum industry. ANON. *Pit and Quarry*, **17** [10], 82 (1929).—The gypsum manufacturing industry has made its greatest growth in the last decade. Future efforts of the industry should be devoted to the development of new products for structural work. R.G.E.

Portland cement production for 1928. ANON. *Pit and Quarry*, **17** [10], 83 (1929).—A monthly summary is given for the production and shipment of clinker and finished Portland cement, by districts, for 1928. R.G.E.

New cement plant. ANON. *Pit and Quarry*, **17** [10], 85 (1929).—Southwestern Portland Cement Co., which has plants at El Paso, Tex., Victorville, Calif., and Dayton, O., plans a new plant at Albuquerque, N. Mex. The initial expenditure will be about $1,500,000. The plant will be built with only one kiln of 2400 bbl. daily capacity, but so designed that additions can be made at any time. An electrical dust-collecting system will be installed. R.G.E.

Manufacture of Portland cement. ANON. *Pit and Quarry*, **17** [10], 88 (1929).—The present status of Portland cement, high silica cements, fineness of clinker grinding, wet and dry processes, short vs. long kilns, the tendency toward complete electrification, and the purchase of electric power are discussed. R.G.E.

Cinders and clinker as aggregate. F. M. LEA. *Pit and Quarry*, **17** [10], 88 (1929).—The value of clinker as aggregate depends less on amount of combustible matter than on content of uncarbonized coal, particularly of high oxygen content. Such coals undergo a progressive expansion when in contact with setting cement. Failures of cinder concretes are rarely due to the presence of sulphur compounds. The corrosion of reinforcements in concrete is due to permeability. A test for the resistance to cracking of breeze or clinker concretes is given. R.G.E.

Pulverized fuel in cement works. ANON. *Pit and Quarry*, **17** [10], 89 (1929).—The latest design of the "Lopulco" system has a new type of continuous, vertical, cylindrical, steam-heated drier with vertical scrapers; an improved rotary feeder superseding the screw design and a new short flame turbulent type R-burner. A dust separator is fitted in the chimney base. Each boiler is entirely independent with its own pulverizer, cyclone, pulverized fuel bin, feeder, R-burner, air heater, dust separator, and induced and forced draft fans, with separate control of adjustment of the pulverizer, feeder, and air supply for the burner. R.G.E.

Kiln for alumina cement. ANON. *Pit and Quarry*, **17** [10], 90 (1929).—A German patent has been applied for on a kiln consisting of a preheating zone, a combustion shaft, and a direct flame fusion chamber. The preheating zone is offset, and not directly above the combustion chamber. The surface of the bottom of the preheating chamber is almost horizontal, so that the raw, preheated material does not fall by itself into the combustion zone, but must be operated by an external source of power. R.G.E.

Stabilizers and plaster composition. A. H. GALLAGHER. *Pit and Quarry*, **17** [10], 90 (1929).—A plaster having uniform setting properties is obtained by adding an alkali-hydrolyzed nitrogenous, organic material, such as glue, together with reground set plaster, or other crystal forming calcium sulphate. The former prevents too rapid setting, and the latter counteracts the effect of retarding substances or conditions. R.G.E.

Tentative specifications for calcined gypsum for use in preparation of dental plasters. ANON. *Proc. A.S.T.M.*, **28** [1], 819–20 (1928).—Calcined gypsums for use in the preparation of dental plasters are products of specific properties with reference to time

of set, fineness, and water carrying capacity. These specifications cover two grades: quick setting and slow setting. The requirements, methods of sampling, and testing are listed. R.A.H.

Consistency measuring instruments for calcined gypsum. ANON. Bur. Stand., *Tech. News Bull.*, No. 142, p. 17 (1929).—At the request of Committee C-11 on gypsum of the A.S.T.M., a study was undertaken of the instruments for determining the standard testing consistency of calcined gypsum. The item gives a brief description of the three instruments used: Southard, Hammond, and modified Vicat. The results obtained on a mix of gaging plaster made up to a standard testing consistency are given as determined by the Southard viscometer. This mix was used with the other two instruments and the results compared. From the results obtained on 6 types of plaster it was found that the modified Vicat apparatus was more sensitive to changes in consistency, easier to operate, and the penetration was more nearly proportional to the consistency than was the spread as shown by the other two apparatus. R.A.H.

Volume changes of Portland cement as affected by chemical composition and aging. ALFRED H. WHITE. *Proc. A.S.T.M.*, **28** [2], 398–431 (1928).—Expansion in water and contraction in air seem to be universal characteristics of Portland cement of even the most diverse chemical compositions. This is shown by graphs of 12 expansion bars prepared from 6 neat commercial cements, and 34 expansion bars prepared from 16 cements burned in the laboratory. The conclusions are reinforced by an equal quantity of material which has not been presented. Most of the bars have been under observation for over 20 years. The extent of the volume changes is influenced to a considerable extent by the conditions surrounding the material during the early weeks of the hardening process. Neat cement bars which lie in water continuously all show slow expansion for 2 years and this expansion may amount to +0.15%. Good cements should show substantially no further expansion if they are kept in water for a longer time. Bars of neat cement which are allowed to dry in air immediately after removal from the molds all shrink, unless they contain free lime, and the shrinkage amounts to between 0.3 and 0.5%. If bars of neat cement which have been in water are transferred to air, they will all shrink from 0.2 to 0.3% if sufficient time is given. The reaction is slow and bars only 1 in. square will not shrink over half the total possible amount in 60 days. Bars which have been placed in air immediately after removal from the molds and allowed to become thoroughly dry in air, expand rather slowly when placed in water. If their colloid has been previously developed by long immersion in water, they will expand much more rapidly on being transferred from air to water. All these factors must be taken into account in determining the influence of chemical composition upon volume changes, but certain factors seem clear. Free lime causes an unusual expansion during the first few weeks in water, but its hydration should be finished in a year and if the amount of free lime is small, the volume changes beyond that time should be normal. If bars of neat cement containing much free lime are placed in air after removal from the molds, there will be the usual contraction for a few weeks, but then expansion will take place due to the hydration of the lime, and the expansion in air will be greater than it would have been if the bar had been kept in water. Exposure of clinker to the weather, or of ground cement to indoor air, will hydrate the free lime in a few months and the cement which has been thus aged will show normal volume changes. Magnesia in combination as silicate is entirely harmless, no matter how much there may be in the cement. Free magnesia hydrates slowly and causes rather slight additional expansion during the first 3 years in water, but if magnesia is present, it causes marked expansion during the period from the third to the tenth year in water. Slow expansion persists for over 25 years. There is danger of free magnesia in cement even if all of the magnesia were present in the raw material as silicate, since lime may displace the magnesia during

the burning process. Increasing the iron oxide in cement seems to decrease volume changes. The cements which have been most constant in volume are those which are rather low in alumina, and contain more iron oxide than alumina. Cements high in alumina have shown rather high volume changes. The one experimental cement which was essentially a calcium silicate showed small expansion when kept continually in water but shrank as much as a normal cement in the air. Aging of a cement which contains free lime will remove the harmful effect of the free lime, but aging does not eliminate the normal volume changes of a cement nor does it seem to lessen them in any material degree. Care should be taken in increasing the percentage of lime in Portland cements for fear of liberating free magnesia. R.A.H.

Plastic mortar compression test for cement. EDWARD M. BRICKETT. *Proc. A.S.T.M.*, **28** [2], 432–47 (1928).—The problem of devising a specification test for Portland cement which will give a true indication of concrete-making qualities is ever assuming more importance. The results of this study furnish a basis for a solution of the problem. The plastic mortar test has several desirable features and offers some interesting possibilities as a specification test for cements to replace the present tension test. The plastic mortar test has all of the advantages of the fluid cement test and one or two which the latter does not have. They may be summed up as follows: (1) it gives a more nearly correct measure of the concrete-making qualities of cement than does any other indicator test used or proposed to date; (2) plasticity of the mortar minimizes the effects of personal factor of operators and of minor variations in technique; (3) specimens are more easily made than in the case of standard Ottawa sand mortar because the mix is plastic and more easily worked; (4) it may obviate the necessity for a single standard sand; (5) it offers an entirely feasible means for making early strength tests; with good control, tests at 24 hours have been shown to be in close agreement with concrete tests at that age; (6) absolute strength of the plastic mortar is fairly close to that of the concrete. In the tests described the differences in absolute strength could be ascribed to differences in size and shape of specimen; 3- x 6-in. cylinders for concrete and 2-in. cubes for the plastic mortar. It appears that the principle of the plastic mortar test might easily be adapted to the solution of certain concrete design and control problems. It might be applied to a strength test for a rating of concrete sands. The work has established the parallelism between plastic mortar and concrete under the same conditions of test. R.A.H.

Canadian-American cement consolidation. ANON. *Chem. and Ind.*, **48,** 174 (1929).—A consolidation of interests has been consummated between the Canada Cement Co. and the Atlantic Gypsum Products Co. The former company retires as a manufacturer of gypsum products in the U.S., having sold its plant at Chester, Pa., to the latter company. The requirements of crude gypsum rock of both companies will be furnished by the Atlantic Co. from its quarries in Nova Scotia. H.H.S.

Cement manufacture in Australia. ANON. *Chem. and Ind.*, **48,** 198 (1929).—A plant is under construction at Berrima, New South Wales, by the Southern Portland Co., which will cost $5,000,000. In addition, $1,000,000 has been spent on the allied works of the Southern Blue Metal Quarries, Ltd. H.H.S.

History of the cement industry. F. B. FRANKS. *Excavating Eng.*, **23,** 104–107 (1929).—Cement manufacture in the U.S. began with the discovery in 1818 of a natural cement rock in Madison County, N. Y., by Canvass White, an engineer engaged in the construction of the Erie Canal. The state of N. Y. denied his application for exclusive right to manufacture cement for 20 years, but granted him $20,000. In 1828 a mill was constructed at Rosendale, N. Y., which name is still largely applied to natural cements in this country. The first Portland cement in the U.S. was produced by the Coplay Cement Co. in 1875. H.H.S.

Enamels

Effect of sulphur on physical properties of gray iron. E. K. SMITH AND F. B. RIGGAN. *Proc. A.S.T.M.*, **28** [2], 205–17 (1928).—A series of experiments designed to show the practical effect of various percentages of sulphur in ordinary gray iron is described. About 200 trial charges were run to get sufficient bars containing increasing amounts of sulphur with all other elements substantially uniform. Curves show that, contrary to general opinion, strength and fluidity of gray iron are not affected by sulphur, even in great excess. Brinell hardness and combined carbon are increased by sulphur, while machineability is correspondingly decreased. Microscopic examination shows increasing sulphide areas, thought to be sulphide of iron in solution in sulphide of manganese, with gradual transition from normal gray iron to austenitic hard iron. There is evidence of solution of sulphide of iron in carbide or iron, and where sulphur is very high of precipitation of iron-iron sulphide eutectic. There is strong evidence that sulphur can be materially reduced by the addition of manganese with the charge. Many defects attributed to sulphur have been due to other causes, and with a proper percentage of manganese, sulphur has little effect on gray iron, at least up to 0.18%. R.A.H.

Physical chemistry of rimmed steel. J. E. CARLIN. *Blast Fur. Steel Plant*, **17** [2], 261–62 (1929).—The terms "rimmed," "open" and "effervescent" are applied to low carbon steels manufactured by the basic open hearth and Bessemer processes to which little deoxidation is applied with the exception of manganese, either in the furnace, the ladle, or the molds. The terms "open" and "effervescent" were prompted by the fact that after the steel is in the molds, the evolution of gas proceeds for a considerable length of time and in appearance is directly opposite to killed or deoxidized steels which lie dead and flat. In the early days of steel manufacture, the main product of the basic open-hearth process was low carbon steel. Before the advent of ferro-silicon and aluminum, steel was deoxidized by ferro-manganese only, which in the ordinary ranges of 0.30 to 0.80% is far from complete. In order to hold the steel in the molds it was necessary to cover the top of the mold with a heavy cast-iron cap or cover, and to hold this in place by means of a steel bar placed across the cap and fitting tightly into two lugs, one on each side. When the ingot had solidified sufficiently the cap was removed. The violent evolution of gas during solidification caused irregular freezing on the mold walls, which resulted in large slivers in the blooms and billets. Blow holes near the surface resulted in small slivers, seams, and laps when the ingot was scaled in the soaking pits and rolled in the blooming mill. F.P.H.

Heat treatment and properties of cast iron. P. SCHOENMAKER. *Blast Fur. Steel Plant*, **17** [2], 283–86 (1929).—The effects of controlled initial melting temperatures and of subsequent heat treatments are studied. Striking results obtained upon properties and structure are outlined. F.P.H.

New type of gas-fired furnace in enameling plant. ANON. *Gas Age-Rec.*, **63** [4], 117 (1929).—A new type of gas-fired furnace has been installed in the Peerless Enameling Co.'s plant. It is a continuous type gas-fired vitreous enameling furnace combining several processes in one. It is strictly automatic in operation. A detailed description is given. F.P.H.

Easily fusible enamels. ANON. *Emaillewaren-Ind.*, **6** [5], 33–35 (1929).—There is no easily fusible enamel without borax, lead enamels being excepted. Fusion is reduced and color darkened by cryolite, resulting in a coefficient of expansion too great for cooking utensils; hence the higher fusion point of such vessels. Metal oxides can be used for part of cryolite and nonpoisonous antimony preparations are available. The practical maximum of the total boric acid plus silicic acid is 60, in any proportion from 0 to 60 for one or the other. Enamels of high coefficient of expansion are needed for ranges and signs. Coefficient of expansion is slightly less in enamel than in steel,

hence enamels which are always under certain pressure, are under less pressure with easily fusible enamels. Enamels for ranges and signs should have nearly the same coefficient of expansion as steel, with low solidification point of the enamel. Enamels for ranges must stand temperature variation and signs must be weather-proof. Fusion with both enamels may be lowered by additional boric acid. Range enamel may contain cryolite since its immunity from temperature change is not so important as it is in cooking utensils. Weather resistance in sign enamels is increased by oxides of antimony and zinc, but the former is sufficient since the latter is expensive. The maximum of boric acid does not yield the most easily fusible enamel as indicated by the feldspar-borax curve shown. The introduction of raw materials other than feldspar in favor of silicic acid, clay, potassium, and soda changes the fusion point. T.W.G.

Manufacture of enamelware. ANON. *Emaillewaren-Ind.*, **6** [6], 42–43; [7], 51–53 (1929).—The practical methods in vogue to obtain different colors for outside and inside of vessels, single and double firing, and the various ways of applying the enamel are described. Methods of obtaining gray-speckled ware abroad and in U.S., decorating of the border, and the straightening of distorted ware after firing are enumerated and discussed. T.W.G.

PATENTS

Tiled wall or the like. GEORGE D. HAINES. U. S. 1,704,537, March 5, 1929. A tiled structure consisting of the combination of a supporting structure, a sheet secured to the structure, the sheet having rows of equidistant holes, and tile covering the sheet and cemented thereto, the tiles having members extending into the holes to locate the tile.

Enameling metal. WESLEY J. BECK AND JAMES A. AUPPERLE. U. S. 1,704,586, March 5, 1929. A vitreous enameled article formed of steel, which except for silicon comes within the mild steel range, and has in addition a quantity of silicon sufficient to give a bond with enamel, when put through an enameling process, but not sufficient to spoil the deep drawing and spinning property in the steel prior to enameling.

Enamels. DEUTSCHE GOLD UND SILBER SCHEIDEANSTALT VORM. ROESSLER. Brit. 303,061, Feb. 20, 1929. An opacifying medium for enamels consists of zirconium oxide which has been heated to a temperature above 1000°C. The opacifying power of other zirconium compounds, and also compounds of titanium or antimony, is said to be improved by the same treatment.

Glass

Manufacture of fused bifocal spectacle lenses. ROBERT J. MONTGOMERY. *Jour. Amer. Ceram. Soc.*, **12** [4], 274–303 (1929).—I. The process of making fused bifocal spectacle lenses is based on patents taken out about 1906. Such lenses are made by fusing a crown glass with an index of refraction of 1.5230 with a lead glass having indexes of refraction of 1.616, 1.66, and 1.69. Problems in making satisfactory glass involve thermal expansion, surface crystallization, surface bubbles, and the softening temperatures of the glasses. The effect of composition of the glass in curing these defects is discussed and satisfactory compositions are given. Testing methods for control are given. A later development is the so-called colorless fused bifocal in which a barium glass replaces the lead glass of the normal lens. The use of barium glass introduces new problems, especially the quality of the glass and the tarnishing of the surface. The relative softening temperatures of the barium and crown glass had to be controlled as well as the thermal expansion.

Die-casting glass. ROY E. SWAIN. *Glass Ind.*, **10** [2], 25–28 (1929).—Die-casting in the metal industry consists of flowing molten metal under pressure into molds by means of a cylinder and piston submerged in the melting pot and connected with the

mold by a spout. The high melting point and physical properties of glass, and the materials needed for melting-pots make necessary special designing of metal die-casting equipment. Equipments designed to cast glass directly from the melting unit have not been used with success. Metals flow freely, while glass is viscous and flows sluggishly. Die-casting of glass is much more wasteful of material as the font is scrap. Very few articles are made by this method that can be produced successfully by straight pressing. The products of the font molds are solid or heavy glassware such as door knobs, strain insulators, etc. Nearly all this ware requires finishing by grinding, and in many cases polishing, to remove the roughness where the sprue is removed. There are several well-defined types of font molds each for a peculiar type of article. The font and plunger, common to all these molds, are given first consideration and a number of them described to point out their advantages and disadvantages. By standardizing the font seat on the molds a single font and plunger may be made to serve a number of molds. This font is wasteful of glass but is justified by the ease of operation, high production and low cost of equipment. Font molds are popular for articles having eyes, such as radio insulators. As in straight pressware the point that fills last is subject to most wear. A joint at this point will soon give way unless especially machined and fitted. The hot glass here receives the full pressure of the plunger before a skin of chilled glass has formed sufficiently to bridge over the joint of the mold. Excessive pressure after the mold fills may strain the article, causing crizzles. These are especially annoying in multiple molds not easily filled simultaneously. Overflowing into a common chamber lessens the probability of these fins and crizzles. A nest mold is used extensively, each cavity equidistant from the well. Small objects must be released from the spring bottom mold almost instantly to prevent the formation of magic blisters. Laps will form in comparatively large articles where back pressure makes the fill, more pronounced in vertical than in horizontal molds. These should be filled from the bottom. Designs should be in such a position that the glass coming through the gate first will not fall upon this design, as this glass is somewhat colder and has a thicker skin than the glass that follows. This colder glass will not take as sharp an impression as the hotter glass. E.J.V.

Manufacture of laminated safety glass. II. JOSEPH ROSSMAN. *Glass Ind.*, **10** [2], 28–34 (1929).—A process of making composite sheets of a more or less translucent character is described in U. S. patent 1,324,361, Dec. 9, 1919. The Mascart process, described in U. S. patent 1,342,267, June 1, 1920, consists of reinforcing glass by a film of gelatin upon the face of a sheet of glass, permitting the film to dry and then superposing a film of cellulose ester in the form of a solution. An improvement which contributes to the increased adhesive power of a celluloid sheet to gelatin consists in mechanically or chemically treating the surface of the celluloid sheet. This feature forms the subject of a divisional patent 1,342,268. In practicing the invention of U. S. patent 1,421,974 a solvent composition is employed, consisting of one of the higher alcohols combined with one or more ingredients. Excellent results have been secured by a composition consisting of fusel oil 83⅓%, and methyl salicylate and camphor 8⅓% each. These proportions vary with the character of the work to be performed. According to U. S. patent 1,467,030, Sept. 4, 1923, the objectionable coloration of the plastic material in reinforced glass may be prevented by using, in place of the ordinary window glass or plate glass heretofore employed, a special glass which will not transmit the more powerful actinic rays such as the ultra-violet. Three examples of suitable glass compositions are given. In accordance with U. S. patent 1,604,761, Oct. 26, 1926, actinic-ray-absorbing or arresting ingredients are incorporated in the safety glass structure. These ingredients may be beta-methyl umbelliforne, acetamino quinolin, aesculine, anethol, quinine sulphate, ferric chloride, potassium dichromate, nickel chloride in combination with aluminum chloride or calcium chloride, salts of certain metals of high molecular weight such as

cadmium, molybdenum, thorium, cerium, uranium, and other or various combinations of these. A good oil-resin varnish is used in U. S. patent 1,647,435, Nov. 1, 1927, of which the following is a typical example: copal resin 1 part by weight, linseed oil 1.5 to 2.5 parts, spirits of turpentine 3 to 5 parts. **III.** *Ibid.*, **10** [3], 57–64 (1929).—In U. S. patent 1,665,913 each sheet of glass is first prepared by a deposit of gelatin on one surface of each piece of glass. One of the sheets of glass is then immersed in a bath of industrial spirit, amyl acetate and tetrachlorethane, and while still immersed the celluloid is placed thereon, in contact with the gelatin. The remaining sheet of glass is placed on top with the gelatin again in contact with the celluloid. The gelatin positioned between the sheets of glass is now immersed in the bath. The three parts are then lightly pressed together and removed from the bath. Sufficient pressure is then applied to cause the gelatin to adhere firmly to the glass. According to U. S. patent 1,478,862, Dec. 25, 1923, the sheet of glass is coated with a glue which is preferably a solution of 44 g. of gelatin to one quart of formic acid, specific gravity 1.06. In U. S. patent 1,560,321, Nov. 3, 1925, the suitably cleaned glasses are treated with a solution of 30 to 60 fluid ounces of water, 70 to 100 g. of deodorized isinglass, *e.g.*, that known as Swinborne's patent isinglass, 15 to 25 g. of British gum, 4 to 8 cc. of acetic acid, and 2 to 4 cc. of glycerine. The solution is applied at about 130 to 180°F and is left to dry. When dry, the coating is treated with a bath of formalin (preferably of 40% strength), in which it is left for a few minutes. According to U. S. patent 1,611,139, Dec. 14, 1926, a sheet of celluloid is coated with a film of castor oil, pressed firmly against the clean surface of glass under considerable pressure, and the film of castor oil entirely squeezed out resulting in an exceedingly tenacious adhesion between the celluloid and the glass, especially after heating. The process of U. S. patent 1,651,581, Dec. 6, 1927, consists in forming a sheet of laminated glass by spraying or otherwise producing a skin of cellulose formate upon one side each of two sheets of glass, then applying vegetable oil, forming cellulose formate skins. The object of the invention of U. S. patent 1,653,040, Dec. 20, 1927, is to produce a mirror which will not shatter if subjected to a severe shock. The object of the invention of U. S. patent 1,656,691, dated Jan. 17, 1928, is to provide the process for producing laminated glass consisting in spraying a solution of cellulose material on a sheet of glass, permitting the solution to dry to form a skin, then spraying or otherwise applying a film or coating of liquid Canada balsam, then applying a film of liquid Canada balsam to a sheet of nonbrittle material such as cellulose composition material, superimposing one sheet upon the other sheet, and then pressing to squeeze out excess Canada balsam and to cause a union between the sheets. U. S. patent 1,655,933, Jan. 10, 1928, effects an efficient union or bond between the sheets of glass and the sheet of nonbrittle material; one surface each of the two sheets of glass is provided with a skin of cellulose composition material, which is applied by spraying the material in solution upon the sheets of glass. The nonbrittle sheet may also be treated to form a similar skin thereon. After the skin has been formed on the sheet it is coated with a film of tetralin or tetrahydronaphthalene. It is sometimes desired to laminate sheets of glass larger than any available single sheet of celluloid and to do this U. S. patent 1,666,252, April 17, 1928, provides for cementing together, or otherwise joining two or more sheets of celluloid to equal in size the glass to be united. In U. S. patent 1,669,044, May 8, 1928, a sheet of glass has a skin formed thereon and a sheet of nonbrittle material such as a cellulose composition material or the like containing a relatively large amount of oil, the process contemplating a treatment of the nonbrittle sheet in a manner to produce a film of oil by bringing the oil out from the body of the sheet, the oil being used to assist in creating an efficient bond between the sheet of nonbrittle material and the skin of glass. The object of U. S. patent 1,670,435, is to form a sheet of laminated glass by spraying or otherwise producing a skin of cellulose composition material upon one side of two sheets

of glass, applying to the skins a film of animal oil, then coating both sides of a nonbrittle sheet of material with a film of animal oil, interposing the nonbrittle sheet between the sheets of glass, and uniting them. The object of U. S. patent 1,670,436, May 22, 1928, is to form a sheet of laminated glass by spraying or otherwise producing a skin of cellulose composition material upon one side of two sheets of glass, applying to the skins a film of mineral oil, then coating both sides of a nonbrittle sheet of material with a film of mineral oil, interposing the nonbrittle sheet between the sheets of glass, and uniting them. The process of U. S. patent 1,692,619 Nov. 20, 1928, consists in cutting two sheets of glass having slight wave formations on their surfaces to substantially identical size, arranging an intermediate sheet of cellulose composition which has been properly prepared, between the two sheets of glass. For Part I see *Ceram. Abs.*, **8** [3], 181 (1929). E.J.V.

Progress in the glass industry. ANON. *Pottery Gaz.*, **54** [620], 263–72 (1929).—Automatic machinery has led to the use of softer glass. Glass containers must be durable, both chemically and thermally. The differences in the various branches of the glass industry lie chiefly in the methods for working up and fashioning the glass. Raw materials for containers consist of quartz sand, soda ash, and limestone (sometimes dolomitic limestone). "Tank" furnaces used, are of the continuous open-hearth, reverberatory type (something like those for steel). The raw materials are charged in at one end and in passing through to the other are completely fused. Bottle furnaces are constructed to hold up to 500 T. but 150- to 200-T. is a usual size. The furnaces used for window glass are often much larger (2000 T. of molten glass). Automatic glass bottle machines may be divided into two classes, the feeder or flow machine, and the suction. Flow machines can again be divided into three broad classes, the press, the press and blow, and the narrow-mouth bottle machine. The press machine is suitable for making simple, wide-mouth pressware, such as tumblers, fruit dishes, jelly molds, etc. The press and blow machine is capable of making a wider range of ware than the press machine because of two sets of molds, the press and the blow molds. The narrow-mouth flow machine will make both narrow-mouth and semiwide-mouth ware, such as sauce bottles, and milk bottles, respectively. The biggest development in modern glass bottle machinery is in the second class, the suction bottle machine similar to the Westlake suction machine for making glass bulbs. All the machines are described in some detail. Both intermittent and continuous annealing processes are in use. The continuous annealing furnace only is worthy of consideration. For making sheet glass there is the Fourcault and Colburn, and the Lubbers cylinder drawing process. Plate glass is made by casting, rolling, and by the Ford continuous process. The Fourcault and Colburn drawing processes are similar. The Bicheroux is an improved casting process for thinner sheets. The rival of the casting process is the Ford continuous plate glass process. Heat-absorbing and ultra-violet ray transmitting glasses are new achievements. It is possible now to obtain glass domestic ware which successfully withstands the cooking treatment. The glass has a very low coefficient of expansion and a high chemical and thermal durability. Spectacle and antiglare glasses absorb the harmful ultra-red and ultra-violet rays, protecting the eyes considerably. A special glass is also made for use in welding and the observation of high-temperature furnaces.

E.J.V.

Scientific and industrial research. ANON. *Pottery Gaz.*, **54** [621], 413 (1929).—Researches on the durability of optical glasses led to a method of increasing the durability of polished glass surfaces. A comprehensive investigation on the coloring of glasses effected the production of a special yellow glass, neutral glasses, dark glasses for sextant shades, and colored glasses for various purposes. The investigation of transmission of light through optical glasses has included special methods of testing and purifying the materials, and methods of testing the transmission of optical glasses photo-

electrically with great accuracy. A novel apparatus for measuring the percentage of light of various colors reflected from powders, papers, etc., has been designed. Study of interferometric method for the testing of microscope object-glasses, led to the design of an interferometer. Improvements in existing illuminating systems have been effected and designs for illuminating systems and object glasses for special purposes have been worked out. E.J.V.

Important minor constituents in glass. W. E. S. TURNER. *Pottery Gaz.*, **54** [621], 436–37 (1929).—Experiments show the glass melted from mixtures containing a substantial amount of moisture differed in their ease of manipulation with increasing moisture content. The glass set rather more rapidly. The theory was that moisture was retained in the glass even after it had been maintained for a considerable period at 1400°C. Recent work by Salmang and Becker brought confirmation. Arsenious oxide though volatile is retained in the glass, a considerable proportion of it being converted to the higher oxide. The respective behavior of ferrous oxide and ferric oxide in small amounts in glass is important in manufacture of ultra-violet light transmitting glass. In these glasses the iron oxide content should be kept below 0.03%, and in the ferrous form. The coloring power of ferrous oxide is the greater. E.J.V.

Glass-brick houses in U.S. ANON. *Pottery Gaz.*, **54** [621], 459 (1929).—A New York firm, representing a European manufacturer of glass bricks, designed various commercial and residential structures of glass. The bricks are ordinary wired glass, but some are pressed, while certain types are blown. All are hollow. The bricks are constructed with alternate grooves for fitting together and fastening permanently with cement. Claims for these glass bricks are greater dispersion of light and hermetical sealing, giving effective insulation against heat or cold and sound. E.J.V.

Fuel oil vs. coal. T. C. MOORSHEAD. *Glass*, **5** [7], 293–96 (1928).—The relative calorific values of the fuels are to be considered as the first factor. The question of economy in the use of either coal or oil depends almost entirely on the relative price of the two fuels. The conclusions reached by M. refer only to the use of the two fuels in the melting and annealing of glass. Advantages and disadvantages are given: (1) Less weight of oil is used per ton of glass melted due to the higher calorific value of oil. (2) Considerable saving in capital expenditure, especially in the construction of the furnace and auxiliaries, can be made in the case of an oil installation; with gas-fired furnaces gas producers have to be provided, and in the furnace itself, gas and air regenerators have to be built. In the case of oil furnaces only small air regenerators have to be built; also the combustion space in the furnace for oil firing is less than in a gas-fired furnace. Saving in capital expenditure in building a glass factory using oil instead of coal is about 14% of the total cost. (3) Less labor is required in the operation of an oil-fired furnace. (4) Saving can be made in the use of electrical power, cooling water, and other auxiliary power. M. has found by actual experience that in the operation of the furnace, excluding the fuel, a saving of 50% is made in the labor and cost of running the auxiliary plant. (5) Gas-fired furnaces show a saving in the repair bill in the case of glass furnaces; oil-fired furnaces cost annually 25% more for repairs than gas-fired furnaces. (6) A furnace efficiency of 15% on coal is considered good; according to the experience of M. a plant has been run on oil with a furnace efficiency of 30%. (7) Oil permits the use with comparative ease of automatic temperature control; controlling producer gas is much more difficult; at least 5% of the fuel can be saved by the use of automatic temperature control of the furnace. (8) Oil may be metered at all points and greater fuel economy is possible. (9) Different fuel oils vary little in calorific value; use of a substitute supply in case the regular supply is unavailable is thus possible without any difficulties. This is not often true with coal. (10) No time is lost by shut-downs to burn out the flues as in the case of producer gas firing. (11) It is easier to handle and

store a large supply of oil than coal. (12) Absence of coal ash and dust keeps the factory and machinery clean. (13) At some plants it is not an easy matter to dispose of the ashes from coal. A.J.M.

First British glass convention. ANON. *Glass*, **5** [10], 432 (1928).—The first convention of the British Glass Industry, which was held at Bournemouth, was arranged by the secretaries of the Society of Glass Technology and the Glass Mfrs.' Federation. The present status and limitations of the English glass industry as well as proposals for further progress were discussed. These lectures are reproduced almost entirely. A.J.M.

Glass furnace construction. A. ALISON. *Glass*, **5** [11], 484 (1928).—Preheating is discussed in detail. A curve shows graphically the manner in which fuel is saved by preheating the air and gas used. A calorific intensity chart for producer gas is given. *Ibid.*, **5** [12], 533 (1928).—A. discusses volume of checker work for regenerators, weight of checker work, gas regenerators, air regenerators, volume of gas regenerator filling, volume of air regenerator filling, length of checkers, and breadth of checkers. The following charts are given: relationship of volume of brickwork to volume of checkers for various ratios of brick to voids; relationship of volume of checker bricks and preheat requirements. *Ibid.*, **6** [1], 8 (1929).—The discussion of regenerators is continued. The following are considered: static drafts, volume of gases to be handled, velocity of flow, draft expended in velocity head, draft expended in friction. A chart shows the circular equivalents of rectangular flues. For preceding abstracts see *Ceram. Abs.*, **8** [4], 258(1929). A.J.M.

Glass industry in Canada, 1927. ANON. *Glass*, **5** [11], 493 (1928).—Production during 1927 was valued at $14,021,778. This was 20% greater than the value for 1926. The 54 plants engaged in the manufacture of glass products during 1927 represented a capital investment of $12,736,057, employed an average of 3120 people, to whom $3,876,959 was paid in salaries and wages. Imports of glass and glassware into Canada, during the calendar year, 1927, were valued at $8,146,698 as compared with $8,515,395 in the previous year. A table gives detailed information in regard to the various kinds of glass manufactured. A.J.M.

Monish automatic bottle machine. ANON. *Glass*, **6** [1], 13 (1929).—The Monish machine is of the suction type, mounts three parison molds and three blow molds, and is electrically driven. No revolving pot is required as the machine takes its glass from a small enclosed forehearth fitted to the furnace, the circulation of glass in the forehearth being maintained by means of a clay paddle, thus exposing a fresh hot surface of glass to each parison mold, which draws its glass from an aperture in the cover of the forehearth. This cover protects the machine from the heat of the furnace and, at the same time, eliminates much of the heat loss by radiation. The various movements of the machine are cam-operated, obviating the necessity for compressed air cylinders, etc. The necessary air ducts for cooling the molds and machine parts are embodied in the machine itself, the only external connection or pipe being that from the fan to the center column of the machine. The capacity of the machine is from 5 to 40 oz., and either wide or narrow neck ware can be made with either plain or outside screw finishes. The outputs are as follows: quarts, 6 to 7 per min.; $12^1/_2$ oz., 7 to 8 per min.; 10 oz., 8 to 9 per min.; 5 oz., 10 to 11 per min. The electrical power required for the operation of a complete unit is: driving the bottle machine, 1.5 H.P.; driving the paddle mechanism, 0.5 H.P.; driving fan for cooling air, 4.0 H.P.; compressed air for blowing bottle, 1.0 H.P.; vacuum pump, 3.0 H.P. A.J.M.

Recent improvements in manufacture of flat glass. H. K. HITCHCOCK. *Glass*, **6** [1], 18 (1929).—H. briefly discusses the cylinder process (machine), the Fourcault, Libbey-Owens, and Pittsburgh Plate Glass processes. In the latter process the sheet

is drawn directly from the bath of glass, and its position in the bath is determined by means of a submerged bar, which prevents it from wandering back and forth. Its width is maintained by means of a tension in the edge, which is regulated by means of two hemispherical-shaped pieces which partially surround the edges and prevent them from becoming too cold. The drawn sheet is elevated through a vertical leer similar to the one used in the Fourcault process, and the glass is cracked off at the top by means of heated ribbons, which clamp the glass and sever it from the advancing sheet. A.J.M.

Haber's glass cell. W. S. HUGHES. *Jour. Chem. Soc.*, p. 491 (1928).—The chief difficulty in the use of Haber's cell is that it does not readily give reproducible results. There is always an asymmetric e.m.f. between the two sides of a glass membrane in contact with the same electrolyte which may take several days to become constant. This asymmetry varies even in different cells made from the same glass. It has also been found in almost every case that the change in e.m.f. of the glass cell corresponding to a given change in p_H of the solution in contact with the bulb varies from cell to cell, and from day to day in the same cell. The use of very thin glass bulbs is recommended. These should be blown as quickly as possible since devitrification may spoil them. Most workers recommend soft soda-lime glass but samples of such glass vary enormously in their suitability. The glass should have a high conductivity. The less Al_2O_3 a glass contains the better it is for glass-cell work. A high soda content tends to increase the conductivity of the glass, whereas potash seems to decrease it. A very satisfactory glass had the following composition: SiO_2, 71.83%; Al_2O_3, 0.44; CaO, 8.36; Fe_2O_3, 0.04; Na_2O, 18.83; SO_3, 0.22. The p_H is maintained relatively constant within the glass phase by the buffer action of the sodium acid silicate in the glass. When the solution in contact with the glass is more alkaline than p_H 13, the glass surface is rapidly attacked. In this range NaOH and LiOH show this effect more than KOH. It is reasonable to suppose that glass is more readily penetrated by sodium and lithium hydroxides than by potassium hydroxide because of smaller dimensions of the ions. A.J.M.

Density of boric oxide glass and the atomic weight of boron. A. COUSEN AND W. E. S. TURNER. *Jour. Chem. Soc.*, pp. 2654–57 (1928).—The densities obtained for a well-annealed boric oxide glass, from material containing total impurity of only 0.17%, lay between 1.843 and 1.845. When purified so as to contain not more than 0.02% impurity, the density of 8 samples of well-annealed boric oxide glass lay between 1.8435 and 1.8446. The mean of 4 determinations on well-annealed boric oxide samples by the specific gravity bottle method was 1.8444 and from a flotation method 1.8439. Fused boric oxide must be heated to a temperature above 1000°C in order to drive off all traces of moisture. Small amounts of moisture have a noticeable effect on the density. The effect of annealing on the density of boric oxide glass is very pronounced. A series of measurements on unannealed specimens gave densities between 1.8008 and 1.8067. The results indicate that the true density of fused boric oxide glass at a temperature between 18 and 25°C is very nearly 1.844. A.J.M.

Automatic bottle-blowing machines. S. G. ROBERTS. *Amer. Glass Rev.*, **48** [20], 15 (1929); *Compressed Air Mag.*, **33**, 12 (1928).—The Mount Reed plant of the F. E. Reed Glass Co., Rochester, N. Y., is equipped with automatic bottle-blowing machines. E.P.R.

New venting machine developed. ANON. *Amer. Glass Rev.*, **48** [21], 17 (1929).—In the course of experiments to develop to a more exact science the making of molds for bottles, containers, and glassware, the Overmyer Mold Co., of Winchester, Ind., encountered difficulty in finding a satisfactory venting machine which would be flexible and economical. After many trials, a satisfactory machine was worked out and made

available to the general mold-making shop. The following are points claimed for the new venting machine: inexpensive, no guesswork, saves 500% on drills, flexible, drills at any angle, vents any hole, direct motor drive, guaranteed, saves 50 to 75% in time over older methods, simple in operation and construction, vents 104 letters per hour, drills steadily. The proper venting of molds assists materially in the production of good containers. E.P.R.

Glass for automatic machine working. ANON. *Nat. Glass Budget*, **44** [37], 11 (1929).—The relationship between the physical properties of glasses and their suitability for manipulation by machine was discussed at the joint meeting of Technical Committees of Europe at Aachen, Germany, by F. W. Adams. Little is known definitely regarding the actual constitution of glass. The effects of the constituents on the physical properties, at working temperatures, have not been fully investigated. The range of chemical compositions of the main types of glass, viz., colorless and pale green, lies approximately between the limits indicated below.

	Flow-fed machines		Suction-fed machines	
	Colorless (%)	Pale green (%)	Colorless (%)	Pale green (%)
Silica	75–73	74–72	75–74	73–72
Lime and magnesia	8–10	8.5–11	9–11	10–12
Soda	17–16	16–15	15–14	14–15
Alumina	0.5	1.5	0.2–0.5	1.5–1

The melting temperatures for colorless and pale green glasses of similar chemical composition to those given above are between 1375 and 1420°, but the temperatures employed will vary according to the size of tank and output required. It is reckoned good tank practice to melt 9 lbs. of batch per sq. ft. of melting surface per hour. The working temperature of colorless and pale green glasses is usually about 1100 to 1200°, but this will vary with the type of feed; slightly more fluid glasses are required for suction-fed than for flow-fed machines, therefore, higher working temperatures. Glass melted at a fairly high temperature works better than glass of the same composition founded at a lower temperature. At high temperatures the reactions between the raw materials proceed rapidly, gases exert a violent stirring action, and, finally, the glass, being more fluid, diffuses more readily and this produces a more uniform glass than that founded at a lower temperature. A further important factor in obtaining homogeneity is the grain size of the raw materials. Large particles, especially of the more refractory materials of the batch, should be avoided. From observations made on the grain size of batch materials it is found that the most suitable size of sand particle for rapid and uniform melting is medium sand. This grading comprises sand grains not larger than 0.5 mm. and not smaller than 0.25 mm. In the case of limestone, angular particles 3 mm. down to dust give the best results, the larger particles being useful as they tend to keep the batch "open" during founding. Mechanical mixing of the raw material is essential for successful founding and to produce homogeneous glass. It is generally agreed that the excessive use of cullet in glassmaking is bad practice, since the resulting glass is "short" in working and the finished ware more susceptible to mechanical shock. A soft glass works well in machines. The most important physical property of glass is its viscosity in the working range. Much work has yet to be done on the problem of viscosity before the values can be correctly applied to glass working on a large scale. In the mechanical manipulation of glass for the manufacture of bottles, the glass is gathered by a feeder and then transferred to the machine. For successful gathering the viscosity curve must not fall too rapidly with rise of temperature. For this reason glasses too high in lime are unsuitable. While in the machine the viscosity of the glass should alter as little as possible with the fall in temperature, until the

pressing and blowing are complete, when it should rise rapidly in order to maintain the correct shape of the article on cooling. If the viscosity curve should rise too rapidly, when the temperature falls, a hard, crinkly skin is formed, together with small cracks and an uneven surface. This frequently occurs with dark green glasses containing iron oxide, manganese, and rather high alumina, but in this case the viscosity of the glass of the surface layer is affected by the drop in temperature due to increased heat radiation. E.P.R.

Society of Glass Technology. ANON. *Nat. Glass Budget*, **44** [40], 7 (1929).—The 112th meeting was held in University College, London, Dec. 19, 1929. W. R. Lyttleton gave a paper entitled "Outline of History, Development, and Methods Employed in Manufacture of Laminated Glass." E.P.R.

Moorshead continuous press and blow machine. ANON. *Nat. Glass Budget*, **44** [41], 3 (1929); See Brit. 297,856, *Ceram. Abs.*, **8** [2], 112 (1929). E.P.R.

Manufacture of glass in 1927. ANON. *Pottery, Glass, and Brass Salesman*, **38** [22], 9 (1929).—The Dept. of Commerce announces that, according to data collected at the biennial census of manufactures taken in 1928, the establishments engaged primarily in the manufacture of glass in 1927, reported products valued at $279,708,063, of which $73,893,205 was of pressed and blown glass. This industry embraces all establishments engaged primarily in the manufacture of glass from raw materials, but does not include those engaged primarily in glass beveling, bending sheet glass, engraving glass, making glass labels, staining and ornamenting glass, or making glassware from purchased "blanks." E.P.R.

Handwork and machinery in glass manufacture. O. KNAPP. *Chem. Rundschau* (Budapest), **5**, 67–69 (1928).—The following are described: modern glass factories, the continuous process used by Henry Ford, Owen's bottle-making machine, Westlake's flask-blowing machine, and Danner's tube-producing apparatus. (*C.A.*)

Effect of solarization on ultra-violet transmission of window materials. W. W. COBLENTZ AND R. STAIR. *Trans. Illum. Eng. Soc.*, **23**, 1121–52 (1928).—The transmission for 302 millimu was measured for various glasses before and after exposure to ultra-violet. Three classes are established: (1) fused quartz, Corex, and Locke glass, with transmission initially over 85%, and little or no decrease on solarization; (2) vitaglass and Helioglass, with transmission initially 45 to 55%, decreasing to about one-half on exposure; (3) common glass and Quartzlite, with transmission initially 0 to 1.5%; there is no change with exposure. The original, and a previous paper (*Ibid.*, **23**, 247), should be consulted for a discussion of ultra-violet therapy. (*C.A.*).

BOOK

The Physicist in the Glass Industry. W. E. S. TURNER. Institute of Physics, London (1929).—Price one shilling. Reprint of a lecture delivered before the Institute. H.H.S.

PATENTS

Forming glassware. RICHARD LA FRANCE. U. S. 1,702,262, Feb. 19, 1929. The method of forming parisons which consists in drawing a measured quantity of glass into the open end of a mold by suction created at radially spaced points at the closed end of the mold, severing the glass and simultaneously closing the open end of the mold, continuing suction after closing of the mold, and substantially simultaneously cutting off the suction and applying air pressure to the glass from the closed end of the mold to give shape to the parison.

Glass-forming machine. ALBERT N. CRAMER. U. S. 1,702,498, Feb. 19, 1929. A tiltable mold bottom comprising an annular section, a plunger section slidable within the annular sections, and means operable at times to interlock the sections including a sliding detent, and a cam to actuate the detent.

Continuous drawing of bulb-edged glass sheets. RENÉ J. DOGNAUX. U. S. 1,702,501, Feb. 19, 1929. In a device for drawing a plurality of sheets of glass having bulb edges from molten glass, a floater block having a plurality of slotlike openings therethrough in the same longitudinal plane, each of the openings being shaped to define a sheet of glass as the glass is carried away from the block and cooling means about the lateral edge of each sheet.

Glass-rolling apparatus. JOHN H. FOX. U. S. 1,702,504, Feb. 19, 1929. In combination with a glass sizing roll, an apron for receiving the glass therefrom, comprising a tubular member adjacent the surface of the roll, means for circulating a cooling fluid therethrough; sheet metal sections, placed end to end, surrounding the member and having tapering lips in opposition to the surface of the roll, and means for applying force at different points along the series of sections so as to resist the tendency of the sections to warp and pull the lips away from the surface of the roll.

Surfacing machine. WILLIAM OWEN. U. S. 1,702,521, Feb. 19, 1929. In combination in a surfacing machine, a supporting framework provided with a vertical guideway, a carrier frame mounted for vertical sliding movement on the guideway and provided with supporting means, resilient adjustable means opposing the downward movement of the carrier frame, a vertical sleeve having means adapted to seat on the supporting means and hold the sleeve against lateral and turning movement, but freely removable therefrom, a runner spindle journaled in the sleeve, a runner secured to the lower end of the spindle below the sleeve, and a drive member secured to the spindle above the sleeve.

Apparatus for trimming glass sheets. WILLIAM OWEN. U. S. 1,702,522, Feb. 19, 1929. The combination with means for moving glass sheets continuously forward, of edge trimming means comprising a pair of cutters mounted above the sheets adjacent the side edges thereof, means for moving the trimming means along the sheets in a direction opposite to the direction of travel of the sheets, and for returning them to starting position after each cut, and means for centering the forwardly moving sheets with respect to the edge trimming means preliminary to the trimming operation.

Apparatus for annealing glassware. JOTHAM F. BLACK. U. S. 1,703,073, Feb. 19, 1929. Apparatus for annealing glassware, comprising a tunnel having side walls provided with longitudinally extending grooves, a flexible conveyer for transporting ware through the tunnel and having the edges thereof, extending into the grooves, and means for centralizing the conveyer relative to the tunnel upon a decrease in the width thereof, occasioned by longitudinal stretching.

Making sheet glass. DOMINIC F. CANNON. U. S. 1,704,552, March 5, 1929. A process for holding up the advance edge of a plastic sheet of glass as it passes from a forming roll onto a runway which consists in applying a blast of fluid between the forming roll and the advancing end of the sheet to lift such end as it passes onto the end of the runway.

Rolling plate glass. LEE SHOWERS. U. S. 1,704,580, March 5, 1929. The combination with a pair of opposing horizontal rolling members, having a pocket therebetween for receiving a body of molten glass to be rolled into a sheet of closure members fitting between the rolls and constituting the ends of the pockets and removable sheet metal plates fitting the inner faces of the closure members.

Glass-blowing machine. LEONARD D. SOUBIER. U. S. 1,705,341, March 12, 1929. In a glass-forming machine, the combination of a blank mold carriage, a blank mold thereon, a finishing mold carriage, a finishing mold thereon, means to rotate the carriages in opposite directions, a blank holding and transferring device mounted on the blank mold carriage, means to actuate the device to transfer a blank to the finishing mold, and means operated from the blank mold carriage for guiding the device and caus-

ing it, while holding the blank, to travel with the finishing mold while the latter travels through a predetermined arc.

Treating glass plates to prevent moisture affecting transparency. OMER DEMARET. U. S. 1,705, 453, March 12, 1929. As a novel article of manufacture for use in coating glass surfaces, a transparent sheet of coagulated cellulose treated with an alkaline solution and having the property of dispersing drops of water and particles of moisture.

Glass tile. J. H. AND D. LOVELL. Brit. 302,062, Feb. 6, 1929. Glass tile for roofs are provided with attachment or suspension lugs or lips in the form of separate pieces of glass which are fused to the tile. Each tile is made from a flat blank, and the operations of bending the tile to the required curve and attaching the lugs are carried out at the same time. A flat blank is placed on a cast-iron mold in such manner that one edge is gripped by three upwardly and forwardly extending hook-shaped projections on the mold. The small pieces of glass forming the lugs are inserted in the spaces between the projections and the whole is then passed into a kiln.

Blowing and pressing glass. NAAMLOOZE VENNOOTSCHAP MAATSCHAPPIJ TOT EXPLOITATIE VAN UITVINDINGEN. Brit. 302,153, Feb. 6, 1929. Relates to a machine for making hollow glassware, particularly electric lamp bulbs, in which parisons are formed by pressing and are afterward blown to shape. The invention consists in making the glass-contacting parts of the parison mold and the plunger of heat-insulating material, and facing this material with metal of high conductivity. The high conductivity of the metal insures that its surface temperature is uniform, so that marks on the finished ware, due to uneven chilling of the glass, are avoided. The heat transmission of the parts as a whole is sufficiently low, however, to prevent too much heat from being abstracted from the glass, but not so low as to permit the metal to stick to the glass.

Pressing glass. W. B. MITCHELL. Brit. 302,193, Feb. 6, 1929. A machine for pressing glass articles, particularly stoppers, comprises a continuously rotating table carrying a number of molds, a plunger for each mold, a device for cutting charges of glass from a flowing stream, and molds each consisting of two pairs of members with a hinged base, a device being provided which, by locking one pair of mold members, also secures the other members and the base.

Rolling glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Brit. 302,283, Feb. 6, 1929. Relates to the method of making sheet glass in which a mass of glass is poured from a ladle or a melting-pot onto a receiving table whence it passes between rollers and is formed into a sheet. According to the invention, a plate is used to prevent the glass from flowing between the rollers until it has spread out evenly between side plates.

Silica-glass articles. QUARTZ ET SILICE. Brit. 302,895, Feb. 13, 1929. Panes or sheets for windows are made of transparent fused silica by submitting a mass of opaque fused silica, which has been heated to a temperature of the order of 2000°C, to a high pressure which is maintained until solidification occurs. The opaque silica, obtained in the usual way by fusing white sand, is squeezed or flattened out by a suitable press exerting a pressure of 200 to 600 kgs. per sq. cm. The small bubbles which cause the opacity of the usual fused silica are compressed or destroyed by the high pressure, and they do not reappear if the pressure is maintained until the silica is solidified.

Heavy Clay Products

Compressive and transverse strength of brick. J. W. MCBURNEY. *Jour. Amer. Ceram. Soc.*, **12,** [4], 217–29 (1929).—This paper reports the compressive strength flat and on edge and the transverse strength of twenty-seven makes of brick covering a range of conditions in method of manufacture and degree of firing. The attempt is

made to correlate the variation in ratios of these different measures of strength with the various structural features of the brick.

Masonry failures due to vertical shear. FRED T. HEATH. *Jour. Amer. Ceram. Soc.*, **12** [4], 230–40 (1929).—Observations and analysis of masonry failures are presented in which vertical cracks result from shear. It is suggested that the scope of laboratory testing of masonry walls be broadened to include a study of vertical shear stresses, and that general conclusions regarding masonry strength take such tests into consideration.

Effect of strength of brick on compressive strength of brick masonry. J. W. MCBURNEY. *Proc. A.S.T.M.*, **28** [2], 605–34 (1928).—Data secured in the testing of 186 brick walls where 5 different makes of brick were used are presented with the following conclusions: (1) Various measures of the strength of brick, compressive, flatwise and on edge, transverse, tensile, and shearing, vary in their relation to each other for different makes of brick. (2) Workmanship, strength of mortar, types of construction, and regularity of size and shape of brick being equal, compressive strength of brick, flatwise, is the most consistent measure of compressive strength of brick masonry on the basis of the data here presented. (3) For the soft-mud and dry-pressed brick the ratios of compressive strength flatwise to transverse strength are fairly constant. The transverse strength of these brick is as good a measure of wall strength as the compressive flatwise strength, possibly better. (4) The ratio of wall strength to brick strength varies with variation in workmanship, strength of mortar, type of construction, and regularity of size and shape of brick. (5) Where there is a difference in strength between brick, the ratio of wall strength to brick strength for the stronger brick is more affected by change of mortar strength than is the corresponding ratio for the weaker brick. (6) Other factors being equal, the brick most regular in size and with plane parallel faces, will give the highest masonry strength. (7) The ratio, strength at first crack to maximum strength of masonry, seems influenced especially by the ratio of transverse to compressive strength and the regularity in size and shape of the brick. (8) On the basis of these data, the mean of a number of determinations of brick strength is as good a measure of brick strength, insofar as it affects masonry strength, as either the norm or mode. R.A.H.

Low cost of building with brick. J. J. STEIN. *Brick Clay Rec.*, **74** [6], 398–400 (1929).—Another more detailed account of the increased use of brick in Alton, Ill. For preceding article see *Ceram. Abs.*, **8** [3], 190 (1929). E.J.V.

Eastern Townships Brick and Tile Co. ANON. *Brick Clay Rec.*, **74** [6], 390–94 (1929).—The plant was built and laid out according to findings from a survey of clay pits, machinery and equipment, and drying and firing systems. Illustrated. E.J.V.

Accomplishments of Structural Clay Tile Association. EDWARD C. KERTH. *Brick Clay Rec.*, **74** [6], 394–96 (1929).—Some of the big things the Structural Clay Tile Assn. accomplished since its 1928 convention are as follows: a standard has been worked out that will be a safe workable guide for the entire industry as a basis for equitable tax return and as a factor for the determination of true costs; a workable agreement has been attained between the Structural Clay Tile Assn. and the Common Brick Mfrs. Assn. which assures a future in the ceramic field where these two major associations can successfully meet the competition of inferior substitute materials; the name of the association has been changed to the Structural Clay Tile Assn. as one more representative of the material itself; a survey of the entire industry was made in order to set up a unified system to determine the cost of production; and definite results have been accomplished through research which included tests on fire resistance, physical characteristics of the raw material and finished product, the development of flat arch floors,

development of a new clay processing which will increase fire-resistance of exposed surfaces and other features that no other competitive material possesses.

E.J.V.

Weather resistance of brick pavements. JOHN M. EGAN. *Brick Clay Rec.*, **74** [6], 396 (1929).—Weathering may attack materials by chemical changes as oxidation of iron, or mechanically as by frost action in stone, or by a combination of both chemical and mechanical actions. Results of rattler tests on paving brick are listed. Not only the effect of moisture but the effect of temperature as well must be considered in a study of the effect of weather on vitrified brick. When it was common practice to lay a brick pavement surface with a cement grout as filler, there was a tendency toward transverse cracking of the brick. This defect has been overcome entirely by the substitution of asphalt or bituminous filler in the place of the cement grout. While heat causes brick to expand, no expansion is noted in the presence of moisture due to the fact that brick is chemically inert. The modulus of elasticity of the material commonly used for pavement construction varies with the amount of saturation. Vitrified paving brick, under all conditions, has a constant modulus of elasticity of 4,000,000 in tension and compression. E.J.V.

Strength of brick. ALFRED B. SEARLE. *Brick Clay Rec.*, **74** [6], 402–403 (1929).—Some fire brick are strongest, not when they are cold, but when being fired under various temperatures. Work done by V. Bodin and Hirsch of Berlin is cited to prove this statement. The various ingredients which may be in a brick seem to exert their greatest influences at different temperatures. Silica brick are weaker at 200°C than at any other temperature below 800°C. The strength increases to that of cold silica brick between 300°C and 575°C, but then falls rapidly as the temperature increases. This is an unexpected result which requires further investigation. E.J.V.

Absorption of clay brick studied. ANON. *Brick Clay Rec.*, **74** [6], 403 (1929).—A study has been made of the absorption properties of 9 different types of clay brick. All brick of one type were made at the same plant and differed from those of other types in the clay used and in details of manufacture. Among the 9 different types investigated were included brick made by the stiff-mud and dry-press processes. The samples of each type were selected to give as wide a range in the properties as could be obtained. The absorption tests included were (1) by total immersion at room temperature, (2) total immersion in boiling water for 7 hours, and (3) partial immersion at room temperatures for several periods. The results of the tests indicated that the relations between the amounts of water absorbed by total immersion at normal room temperature and by boiling were given closely by the empirical equation:

$$Y = KX^3 \text{ or } Y = K\left(\frac{Y}{Y+Z}\right)^3, \text{ where}$$

Y = vol. of water absorbed per unit of bulk volume of brick after total immersion at room temperature (taken at a period when the gain in the weight of the brick was less than 1 g. per 24 hours). $Y + Z$ = volume of water absorbed per unit of bulk volume of brick after 7 hrs. total immersion in boiling water. K = a constant for one make of brick.

$X = \frac{Y}{Y+Z}$ = a ratio of absorption by cold immersion to absorption by boiling. The absorption constant K was different for different types of brick, but was essentially constant for any one make of brick. Since the values of K were independent of the degree of firing and were constant for brick made from the same clay by the same manufacturing process, there seems to exist the possibility that clays may be classified

in accordance with these values, though it has not been determined definitely to what extent (if any) they are affected by the manufacturing process. E.J.V.

"Thermos" brick. A. H. STAMM. *Clay-Worker*, **91** [2], 157 (1929).—S. claims the "thermos" brick will revolutionize the building brick industry. The brick is fire-proof and moisture-proof. It is to be manufactured from fire clay with a salt glaze finish. The brick will be made 5 x 12 in. with a rough texture surface. It is claimed this brick will cut building costs and that a house can be constructed for less with this style of brick than of frame. E.J.V.

Vitrification and firing of ferruginous clays. PIERRE BREMOND. *Brit. Clayworker*, **37** [442], 422–23 (1929).—Three ferruginous clays and two sands were studied. The iron and quartz content of these clays were as follows:

	Clay I	Clay II	Clay III	Sand I	Sand II
Quartz	39.3	24.5	43.3	41.2	69.3
Ferric oxide	8.0	6.6	6.4	4.3	1.7

These materials were chosen because of their high iron content. Clay I is a brick clay, and clays II and III stoneware clays used for glazed pipe. Both the sands were clayey. Research was to ascertain (1) progressive vitrification by measurement of porosity, at 920°C at 40°C intervals, until squatting occurred; (2) the influence of oxidizing or reducing, and of firing rate on vitrification. There was marked difference in vitrification, according as the atmosphere is oxidizing or reducing. In the latter, vitrification commences at much lower temperatures than in the former. In an oxidizing atmosphere there is little change between 960 and 1040°C. The sands show practically no change until 1100°C is reached. These experiments show that reducing action on ferruginous clays is very violent and hastens vitrification considerably. The results also show that there is little change in the porosity over certain temperature ranges indicating that when using these clays in a manufactured product there is no advantage in heating them beyond a certain temperature or else heat them much higher than the upper limit of the temperature range within which it was found little change was effected in the porosity. These experiments also show that overfired goods are not necessarily the result of excessive temperature, but may be due to temporary reducing effects produced by poor draft, bad setting, or overfeeding of the firegrates and production of heavy smoke. The presence of quartz or sand or clayey sand facilitates the firing by rendering vitrification more progressive and less sensitive to temporary abnormal conditions of kiln atmosphere. R.A.H.

Tentative specifications for sand-lime building brick. ANON. *Proc. A.S.T.M.*, **28,** [1], 840–41 (1928).—The bricks shall be classified as hard, medium, and soft on the basis of absorption limits and modulus of rupture which are tabulated. The requirements as to test specimens, size, inspection, and rejection are given. R.A.H.

Tests of clay and concrete load-bearing pipe. W. J. SCHLICK. *Proc. A.S.T.M.*, **28** [2], 635–46 (1928).—Our increasing knowledge of the conditions pipe must meet in service has made more general the testing of all sizes and classes of pipe. Although the test methods in the standards, and tentative standards, for drain tile, for sewer pipe and for reinforced concrete pipe are very similar, they are not identical in all their provisions. Some of the common problems of test procedure are discussed. Because of the wide use of the strength test, particular attention is given the problems encountered in the use of the two most common of the standard bearings, sand bearings, and 3-edge bearings, in tests of different sizes and classes of pipe and to the necessity for controlling the moisture and temperature of the specimens if truly comparable test results are to be obtained. The real meaning and value of the absorption test result are subject to so much discussion and the prescribed methods so frequently criticized as being unfair that these questions are taken up. Certain common but incorrect pro-

cedures in the drying and immersion treatments are pointed out. The freezing and thawing test is the only direct durability test that has been standardized. The development of this test, and experience in its use by one large consumer, are given briefly. The problems of durability against chemical attack have been solved only partially; discussion of them is deferred till more definite and conclusive research data are available. R.A.H.

A.S.T.M. specifications for sewer pipe and fiber strength of the material. F. B. LYSLE. *Proc. A.S.T.M.*, **28** [2], 647–53 (1928).—The A.S.T.M. specification for clay sewer pipe and cement sewer pipe, and U. S. Bureau of Public Roads specifications for pipe for highway work, and the relation of these specifications to the fiber strength of the materials used are discussed. The strength specifications for clay sewer pipe or concrete sewer pipe may be approximated by several methods: (1) by the arbitrary assumption of safe loads derived from an accumulation of test data; (2) by assuming a definite unit fiber strength and designing the thickness of the barrel and the load accordingly; (3) by assuming the loads from certain heights of trench fill and designing the pipe to fulfill the conditions. The present A.S.T.M. specifications were evidently arrived at by the first method. The third method could not be readily followed, unless the load requirements were made great enough for the deepest trench fill, and in this case the pipe would be uneconomic for a majority of its uses. The second method would seem to be the one which should be used. R.A.H.

Staining and efflorescence on Indiana limestone. LEE HUBER. *Proc. A.S.T.M.*, **28** [2], 695–713 (1928).—Descriptions are given of the source, cause, mechanism, and prevention of efflorescence and staining on Indiana limestone caused by moisture seepage through the wall backing material. Most of the statements made are substantiated by actual observation or experimental work. This is especially true of the section dealing with staining. The results obtained indicated very strongly that the best method for the prevention of both efflorescence and staining lies in the following of proper construction practices which eliminated all moisture seepage through the wall. Experiments on twenty-one different brands of commercial waterproofing materials show that they could not be depended upon for preventing the occurrence of efflorescence or staining. An experiment performed by painting the back of stone with a mortar made from a good waterproofed cement indicated that this is a very promising line of attack for the prevention of efflorescence or for the prevention of any other phenomenon the existence of which is maintained by seepage of moisture through the wall. R.A.H.

Estimating hollow building tile. HARLEY M. WARD. *Bldg. Age*, Feb., pp. 92–93 (1929).—W. shows how to figure the number of various sizes of hollow building tile in the wall of buildings. T.W.G.

Higher duty on barium chloride necessary to equalize costs. ANON. *Amer. Glass Rev.*, **48** [21], 14 (1929).—An increase of 50% in the tariff on imported barium chloride will be necessary to equalize the costs of production in this country and abroad. E.P.R.

Extended use of paving brick. ANON. *Mfrs. Rec.*, **95** [8], 61 (1929).—Plans to obtain appropriate and adequate recognition for paving brick in the roads and streets construction program in the U.S. this year were discussed and put in motion by members of the National Paving Brick Mfrs. Assn. in a recent convention. Because of climatic conditions and other features the South was regarded as a particularly good field and the experiences of various southern states with paving brick are expected to help in the campaigns for contracts. E.P.R.

Hartford I. S. machine. ANON. *Glass*, **5** [12], 528 (1928).—This new machine was designed to allow flexibility so that both large and small orders could be executed

efficiently and economically. No rotating tables, fixed cams, etc., are used. The parison molds are on one side and the finishing molds on the opposite side of a common base. These molds are arranged in rows, a finishing mold being opposite a parison mold. The parisons are transferred from the molds in which they are formed (inverted as usual) to the finishing molds by a revolution of 180° about a horizontal shaft. Gob feeding is used. The machine is illustrated. A.J.M.

Concrete highway construction materials. J. W. KELLY. *Pit and Quarry*, 17 [9], 65–69 (1929).—The most striking development in concrete highway construction materials is perhaps not so much in the materials themselves as in the attitude of those who deal with them. There is a more intelligent demand on the part of the user of concrete, a spirit of research in the materials industry, and a growing disposition on the part of aggregate producers and dealers to take advantage of this research by promoting their product on a basis of quality as well as cost. There is a realization of joint responsibility on the part of the owner, engineer, architect, contractor, cement manufacturer, aggregate producer, reinforced and machinery manufacturer, inspection organization and allied interests to meet the general demand for concrete of standard quality. R.G.E.

PATENTS

Hollow-block wall construction. JOSEPH M. LAWTON. U. S. 1,703,155, Feb. 26, 1929. In a hollow wall construction, a pair of walls arranged generally at a right angle, each wall embodying horizontal layers of hollow blocks, the blocks in each layer comprising pairs of spaced longitudinal hollow blocks, each longitudinal hollow block having a continuous cell extending throughout the major portion of its length and passing through the top and the bottom of the same, and transverse blocks disposed between the ends of the longitudinal blocks and having interlocking engagement therewith, each transverse block having a continuous cell extending throughout the major portion of its length and passing through its top and bottom, the transverse blocks in one layer being disposed generally centrally of the longitudinal blocks in the next layer and having their cells in free communication with the cells of the longitudinal blocks and also in free communication with the passage between the longitudinal blocks, and hollow corner blocks arranged alternately longitudinally and transversely in each wall at the end thereof, each corner block having a pair of spaced longitudinal webs providing a central passage and cells upon opposite sides of the central passage, the cells and passage being continuous and extending throughout the major portion of the length of the corner block, the corner blocks in the two walls being positioned at generally a right angle in relation to each other and overlapping whereby their passages and cells are in free communication, the longitudinal corner blocks in each wall extending across the adjacent transverse blocks whereby their cells and passages are in free communication with the continuous cells of the transverse blocks and also overlapping the ends of the adjacent longitudinal blocks, the passages of the longitudinal corner blocks being in communication with the passages between the adjacent pairs of longitudinal blocks, and means for effecting interlocking engagement between each corner block and the adjacent blocks in the same layer.

Veneer tile. HOMER GRIMES AND HOLLIE B. STOVER. U. S. 1,703,998, Feb. 26, 1929. A veneer tile having a lower brick-simulating portion which increases gradually in thickness from its lower to its upper edge, and a relatively thin attaching flange integral with and projecting upwardly from the brick-simulating portion, the rear faces of the brick-simulating portion and flange being in a common plane which is inclined when the tile is attached, disposing the front face of the brick-simulating portion in a vertical plane, the front face of the flange being rearwardly offset from the front face of the brick-simulating portion and disposed in a plane parallel with that in which the rear side of

the flange is disposed, whereby the inclined side of the brick-simulating portion of an overlying tile may lie tightly against the front side of the flange.

Building construction and plastic block for making the same. ANSON F. LEWIS. U. S. 1,704,255, March 5, 1929. In a building construction, a foundation, a wall comprising hollow interlocking plastic blocks arranged upon the foundation, the cavities in the blocks being in alignment, a reinforcing member embedded in the foundation and having a hooked portion thereon projecting into the aligned cavities, a reinforcing member extending through the cavities and having means thereon for engaging the hooked portion, and means to anchor the upper portion of the second mentioned reinforcing member to the wall.

Refractory building material. G. AND R. KNUDSEN AND V. M. GOLDSCHMIDT. Brit. 301,547, Sept. 3, 1927. Ground olivine rock or olivine sand is subjected to treatment causing recrystallization and cementing together of the particles; *e.g.*, it is heated at a suitable temperature in the presence of substances such as magnesium, alkali, or alkaline-earth salts, etc., which assist the recrystallization of magnesium orthosilicate. Binders, *e.g.*, sodium silicate, syrup, etc.; iron compounds, *e.g.*, magnetite; aluminium compounds, *e.g.*, clay; and other substances may be added, and the mixtures may be molded before heating. (*B.C.A.*)

Disintegrating clays. J. F. NEWSOM. Brit. 302,420, Feb. 6, 1929. Discussion on the arrangement of a wet-separating plant, endless band and like conveyers, crushing mills, and endless moving sieves. Clays delivered by excavators or dredging devices are fed on to an apertured conveyer which allows granular material to pass into screening devices and delivers clay to devices which distintegrate the clay by driving it through the apertures in the conveyer.

Slag brick. S. YOSHIMOTO, T. OKUMURA, AND S. NAKAMURA. French 620,456, Aug. 18, 1928. Copper-refinery slags are cast into brick shapes in suitable molds, and when the bricks are still red-hot they are covered with a mixture of mica, powdered iron, sulphur and straw, and allowed to cool slowly under a layer of ashes. (*B.C.A.*)

Refractories

Effect of typical slags on fire brick with a method of determination correlated to service. CHESTER E. GRIGSBY. *Jour. Amer. Ceram. Soc.*, **12** [4], 241–63 (1929).—In an investigation of the problem of producing refractories which would give maximum resistance to slags encountered in service, laboratory slag tests were made in a rotary slagging test furnace. A photograph and sketch of the furnace are given and the method of operation is described. A photograph of a typical test is shown and test data are given for typical high iron oxide, high lime, and high soda slags. These data include the numerical rating of ten test brick in each case. Ten slag tests have been made with 50 different mixes, all in the field of the fireclay and disaspore refractories. Brick of the brands which give best results in the laboratory, were tested in service in malleable iron air furnaces, gray iron cupolas, and "bull" ladles where sodium carbonate purifier is used. Operating conditions are given and chemical analyses of slags presented in several instances. Special firing treatment was given a few brick prior to service tests. Excellent correlation between laboratory and service tests was obtained in cases where high temperature abrasion was not severe, demonstrating the reliability of the rotary furnace type of slagging test in predicting service results insofar as slag alone is concerned. Of equal importance with the reliability of the slag test is the need of a reliable high temperature abrasion test. The data indicate that in many installations high temperature abrasion is the major cause of failures that are charged entirely to slag erosion. Appearance of the brick usually gives little clue as to the

destructive agent responsible. The best brick for service in any given installation depends on which destructive force is the greater.

Service of refractory blocks in small experimental glass tank. W. L. PENDERGAST AND HERBERT INSLEY. Bur. Stand., *Jour. Research*, **2** [2], 453–65 (1929); see *Jour. Amer. Ceram. Soc.*, **12** [2], 123 (1929); *Ceram. Abs.*, **8** [4], 273 (1929). R.A.H.

Sagger investigation. ANON. Bur. Stand., *Tech. News Bull.*, No. 142, pp. 17–18 (1929).—A brief summary of the work and results obtained on a series of 39 different experimental sagger bodies. The results show that the resistance to failure of a sagger to thermal shock (1) decreases rapidly with increased temperature of firing of saggers, (2) is less for bodies having a porosity of 25% when compared with those which have a porosity lower than 25%, (3) is greater for saggers containing grog of relatively high porosity than those containing grog of low porosity, (4) is considerably greater for bodies having a low coefficient of expansion below 200°C. R.A.H.

Bricks for pulverized fuel furnaces. ANON. *Brit. Clayworker*, **37** [442], 421–22 (1929).—The early use of pulverized fuel and the troubles experienced with the refractory boiler settings are discussed. The whole outlook was most discouraging at first, but ingenuity, enterprise and an intensive study of the underlying principles and facts enabled engineers and furnace builders to learn much about practical furnace construction. The early installations for burning pulverized coal under steam boilers had solid walled furnaces which were merely an adaptation of the stoker furnaces of the time. The article discusses how the brick wall was gradually replaced by the water cooling for furnace walls. Fundamentally, the application of steam and water cooling has become so well established that there is a serious risk of the use of firebrick walls in pulverized fuel furnaces becoming obsolete. If fire brick are to be used, a coating of neutral or basic material must be found which will not attack the brick and the surface of the brick must be kept below the temperature at which active chemical combinations can occur. In the latter case the surface of the brick must not exceed 600°C. Much can be done by using hollow walls. R.A.H.

Measuring thermal conductivity of insulating and refractory materials. M. L. HARTMAN, O. B. WESTMONT, AND C. E. WEINLAND. *Proc. A.S.T.M.*, **28** [2], 820–47 (1928).—A series of conductivity measurements was carried out to investigate methods that might be used as standard tests. The modified guarded hot plate type of apparatus can be used for making thermal conductivity measurements at mean temperatures up to approximately 1800°F. The heater plates must be calibrated to correct for excessive power losses due to the increased electrical conductivity of alundum at high temperatures. The same apparatus can be used to measure the thermal conductivity of (1) organic or hydrated insulators, (2) medium to high temperature insulators, and (3) refractory materials. The reliability of the conductivity measurements is estimated to be about 2.5%. The apparatus and methods described appear to be of sufficient accuracy and reliability to be given consideration for specifications and the establishment of standards. R.A.H.

Brick meter. STUART M. PHELPS. Amer. Refract. Inst., *Tech. Bull.*, No. 27 (Sept. 1928).—The brick meter is a device which measures the three dimensions of a brick in a rapid and simple manner. It employs the principle of measuring between plane and parallel plates. The measurements may be made by unskilled help and the rugged construction of the apparatus should make it a lasting piece of equipment. Provision is made of the adjustment of the plates for parallelism and for any wear. All of the moving parts are designed for long use and the castings are sufficiently heavy to give strength and rigidity. The meter weighs 60 lbs., is 16 in. high, and measures 12 in. in width and depth. A number of the cast-iron parts could be cast in special aluminum if a lighter model were desired. There seems to be considerable interest in

the apparatus and it is hoped that the principle employed by it will be adopted as a standard method of measuring brick. It is realized that larger tolerances must be allowed when this method is used since it gives the maximum or over-all size. F.P.H.

Analysis of bauxite and refractory products of high alumina content. G. E. F. LUNDELL AND J. I. HOFFMAN. *Ber. deut. keram. Ges.*, **9** [12], 613–17 (1928); see *Ceram. Abs.*, **7** [10], 718 (1928). F.P.H.

Comments on the work of Willi M. Cohn. W. MIEHR, J. KRATZERT, AND H. IMMKE. *Ber. deut. keram. Ges.*, **9** [12], 619 (1928).—Cohn's work on thermal conductivity, thermal expansion, specific heat, and some other thermal properties of minerals is discussed. F.P.H.

Report of Sagger Committee of the German Ceramic Society. ANON. *Ber. deut. keram. Ges.*, **9** [12], 620–52 (1928).—The following papers are abstracted: (1) "Suggestions for the Laboratory testing of Sagger Bodies," by E. Kieffer; (2) "Problems in the Manufacture of Saggers," by H. Kohl; (3) "Possibilities of Improvement of Thermal Conductivity of Saggers," by W. Steger. F.P.H.

Destruction of brick by carbon monoxide. E. DIEPSCHLAG AND K. FEIST. *Blast Fur. Steel Plant*, **17** [2], 280–82 (1929); for abstract see *Ceram. Abs.*, **8** [3], 193 (1929). F.P.H.

Load test for refractories. C. E. BALES. *Blast Fur. Steel Plant*, **17** [2], 321 (1929).—The A.S.T.M. specifies a load of 25 lbs. per sq. in. with the brick placed on end and heating to 2642°F in $4^1/_2$ hrs., maintaining this temperature for $1^1/_2$ hrs. The load is applied by means of a calibrated coil spring in the furnace used by the Refractories Fellowship at Mellon Inst., while some furnaces employ levers and weights for the loading. Several points in the operation of the spring type furnace make it superior to the lever type. This test was developed to show the refractoriness of brick, does not fulfill its objective nor does it show what the actual performance will be in service. Hard firing and fine grinding will give the best results in the experiments, but not necessarily the best results for all types of service. This test while good for control purposes, must be used carefully in specification. A test made with brick under a pressure of 25 lbs. per sq. in. and heated throughout to 2642°F for 7 hrs. does not compare with a test duplicating this time and temperature conducted on the same brick but with only one face heated, as would be the case in actual practice. Furthermore, most furnaces have an insufficient load to bring about failure in this way, and it was stated that this test is not suitable for specification purposes except where the brick are heated throughout. It is often impossible to secure different qualities in the same brick; therefore, the most important qualities for the individual case should be specified. Users should make suitability tests and from them develop control tests. The final answer in every case is the furnace trial. When a brick gives good service, the properties should be noted and used as specifications for control of further shipments. F.P.H.

A. P. Green builds third unit. ANON. *Blast Fur. Steel Plant*, **17** [2], 321 (1929).—The installation of Unit No. 3 of a series of continuous tunnel kilns at the A. P. Green Fire Brick Co. plant at Mexico, Mo., is being made by the Harrop Engineering Co., and the H. K. Ferguson Co. The first two units of the series are now in operation. Construction of the third unit will get under way immediately, and may be completed next spring. It will have a capacity of 36,000 brick daily. It is understood that the contract which also includes part of a grinding plant to be completed when the series of tunnel kilns are finished, approximates $300,000. F.P.H.

Slagging and fluxing of firebrick. G. A. RICHTER. *Blast Fur. Steel Plant*, **17** [2], 321–22 (1929).—No satisfactory laboratory test has yet been devised to simulate fluxing or slagging in actual practice. In service of some kinds, as for instance in ce-

ment kiln work in which the fluxing agent is quite definitely known, the cone test is used. In this test an equal proportion of the fluxing agent such as cement clinker, in the case of cement work, is mixed with an equal proportion of fire brick, finely ground, and formed into tetrahedra and fired in the clay testing furnace until soft. By comparison, knowledge is obtained as to fluxing resistances of different kinds and grades of fire brick. The use of specifications in purchasing fire brick, and the use of laboratory test methods in predicting service qualities have not eliminated all of the uncertainties. Of a number of brands of brick which might meet specifications, some are found to give satisfactory service in one installation and fail to do so in another. Some brands have been found to give best service in one plant and some in another. The reason for these variations lies in the almost countless combinations of conditions, many of which are not understood. But the intelligent use of specifications and test work has eliminated the entirely unsuitable product and increased the margin of safety. Better interpretations of causes of failures, with improved specifications are certain to develop rapidly. F.P.H.

Work of the American Refractories Institute. II. VON PHILLIP. *Feuerfest*, **4** [12], 181–87 (1928).—Abstracts and discussions are given of the publications of the American Refractories Institute issued during 1926 and 1927. F.P.H.

Measuring thermal expansion of refractory materials up to 1600°C. K. ENDELL. *Feuerfest*, **5** [1], 3–4 (1929).—The apparatus consists of a binocular telescope combined with a high temperature test furnace. The test pieces used are 10 cm. in length and are made in prism-shaped bars or cylinders. See also *Ceram. Abs.*, **8** [2], 118 (1929). F.P.H.

Preparation of refractory materials. WALTER OBST. *Feuerfest*, **5** [1], 4–5 (1929).—A survey is made of recent patent literature on the preparation of refractories. The Guardian Metals Co. is working on a new patented process for manufacturing a refractory consisting of 80.5 to 82.5% zirconium oxide, 9 to 11% SiO_2 and 7.5 to 9.5% graphite. The Electric Refractories Co. has a new refractory for use in preparation of crucibles, muffles, furnace refractories, etc., which is made of fused magnesium oxide, graphite, organic or inorganic binders such as tar, pitch, clay, and fluxing agents such as iron oxide or soda. Wagemann has a patent for a refractory product consisting of a mixture of quartz, sand, clay or similar SiO_2-rich material, and clay containing a 10% addition of an artificial Al_2O_3-rich silicate which is added in the colloidal form. The Deutsche Isola G.m.b.H. has a very interesting insulating material made of MgO-rich minerals such as dolomite, hornblende, magnesite. These materials are melted and made into fibers which are very refractory and can also be used as an acid-proof filtering medium. Numerous other patents are discussed. F.P.H.

Determination of specific gravity of refractory material. E. KÜHN. *Feuerfest*, **5** [1], 5 (1929).—A description is given of a gas expansion apparatus used for determining the porosity and specific gravity of silica brick. F.P.H.

Slag- and ash-resistance brickwork. C. PRESSWOOD. *Fuel Econ.*, **3** [36], 759–60 (1928); *Feuerfest*, **5** [1], 10 (1929). F.P.H.

Refractory jointing materials. C. PRESSWOOD. *Fuel Econ.*, **3** [35], 721–23 (1928); *Feuerfest*, **5** [1], 10 (1929). F.P.H.

Identification of dumortierite as grains; dumortierite in Cornish granite. A. W. GROVES. *Mineral. Mag.*, **21** [121], 489–92 (1928).—These notes are intended to bring to notice the possible confusion between blue tourmaline, purple tourmaline, glaucophane, lepidolite, andalusite, pleochroic sillimanite, and dumortierite. Dumortierite (when blue) is very liable to be passed over as the more common glaucophane, the optical properties of the cleavage-flakes of these minerals being similar in several respects. Text-books differ as to the nature of the dispersion in dumortierite, but the majority

give $\rho < \nu$. All the grains mentioned in these notes, as well as a specimen of dumortierite from Dehesa, Calif., in the collection of the Imperial College, gave $\rho < \nu$. Generally this is quite marked. F.P.H.

Boehmite. J. DE LAPPARENT. *Mineral. Mag.*, **21** [122], 559 (1928).—Boehmite is an aluminum hydroxide, assumed to be $Al_2O_3 \cdot H_2O$, occurs as microscopic orthorhombic crystals (distinct from diaspore and isomorphous with lepidocrocite) forming a constituent of some bauxites. F.P.H.

Silica brickmaking in N. Wales. W. B. HARTLEY. *Refract. Jour.*, **4** [41], 138–40 (1929).—The history of the industry and methods employed are discussed in detail. E.P.R.

Manufacture of nonclay refractories in U.S. W. HAMILTON GORDON. *Refract. Jour.*, **4** [41], 154 (1929).—The Department of Commerce, Washington, announces that, according to data collected at the biennial census of manufactures taken in 1928, the establishments engaged primarily in the manufacture of nonclay refractories in 1927, reported products valued at $22,251,802. E.P.R.

Refractory materials in the nonferrous metal industry. SEARLE. *Metal Ind.*, Jan. 11, pp. 57–59 (1929); *Refract. Jour.*, **4** [41], 160 (1929).—The chief uses of the refractories employed in the nonferrous metal industry are discussed and the future prospects of their developments cited. The following applications are dealt with in detail: electric furnaces, gas firing, oil firing, furnace linings, firebrick linings, crucibles, monolithic linings, and new materials. E.P.R.

Silica fire brick. GEOFFREY W. M. REES. *Refract. Jour.*, **4** [41], 142–47 (1929).—Silica fire brick was first manufactured in Europe in 1822 by Young. He started the manufacture of ganister brick in Sheffield in 1858. Silica brick are chiefly used where great heat resistance, combined with all absence of shrinking, is essential as in the lining of furnaces, *e.g.*, Bessemer converter, and for arches, crowns, and higher and hottest parts of furnaces and kilns. Coke ovens are nowadays constructed almost entirely of silica brick, including the regenerators underneath. Two essential ingredients of silica brick are (*a*) silica in the form of a coarse powder, (*b*) binding material. Quartzites and siliceous rocks are used if they are hard, possess a granular structure, and contain a high percentage of silica coupled with a low percentage of alumina and alkalis. The materials should not shatter badly on heating but should show a marked expansion. Ganister is a very suitable material. It has the added advantage of containing a small amount of clay, which reduces the quantity of bond needed to obtain cohesion. It expands 10 to 12% on heating. Ganister is usually mined. Quartzite, a coarser grained material, containing very little natural binding material, is very largely used. Vein quartz is unsuitable as it shatters on heating, owing to occluded water and carbon dioxide. The refractory character of a brick is dependent on the nature and amount of the added bonding material. In considering the qualities to be desired in silica rocks it is important to distinguish between the coarse ganister fragments that form the aggregate of a brick, and the finely ground material, the interstitial matter, or "ground-mass." The production of the bond is aided by the latter, and this facilitates the conversion of quartz into these higher temperature modifications of silica, on which the refractory character and strength of a silica brick mainly depend. In the finished brick, this aggregate is little altered, but the "ground-mass" has its original structure entirely obliterated, and the main consideration is its chemical composition. Originally, a clay bond was used. Nowadays, for general purposes, lime has proved very satisfactory. The percentage of lime added varies according to the type of silica-rock used, and the proportion and purity of the ground-mass in the crushed material. Soluble bond has been tried to insure better distribution. Calcium chloride was unsuccessful owing to the evolution of hydrochloric acid gas on firing. Soda

compounds are occasionally used as bonds but a more fusible brick is produced. Aluminium sulphate and colloidal silica have not proved a success. Ammonium alum has been more useful. At the ordinary temperature, natural α-quartz is stable. This is essentially a low temperature mineral, and neither grows nor is deposited in silica brick, during either manufacture or use. When heated to 575°C, quartz undergoes a reversible transition to β-quartz, the change being accompanied by a sudden expansion. Heated to above 870°C, β-quartz gradually reverts to tridymite, and on raising the temperature to 1470°C, tridymite forms cristobalite; but in the absence of fluxes, quartz changes straight to cristobalite. Both tridymite and cristobalite have their own modifications: α tridymite 117°C, β_1 tridymite 163°C, β_2 tridymite α cristobalite 200 to 240°, β cristobalite. Thus, there are seven modifications. A diagram illustrates the limits of the various phases. The importance of these modifications lies in the volume changes associated with them. The specific gravity of quartz is 2.65, tridymite 2.27, cristobalite 2.33. Thus, there is a very considerable expansion on heating quartz. The minor inversions are comparatively rapid either way. They are also important because of the volume changes accompanying them. This brick should contain a large proportion of tridymite. The melting points of the various forms of silica are: quartz 1500°C, tridymite 1670 ± 10°C, cristobalite 1710 ± 10°C. Investigations have been made to find some catalyst for the inversion to tridymite. One to 1.5% iron oxide in the matrix increased the cristobalite-tridymite inversion. It is the only catalyst known. Firing must be slow and regular, particularly between 500 and 700°C, the α-β quartz inversion range. The slowness of heating also favors the formation of larger crystals of tridymite which, by their angularity and interlacing, add to the stability of the brick. After this the temperature may be increased more rapidly, finally attaining at least 1500°C, which temperature is maintained for 48 hours, to allow thorough inversion of the quartz. This is the "soaking" period. The complete firing takes about seven days. Cooling takes longer, for this process must also be very slow, down to below 200°C, the α-β cristobalite inversion point. E.P.R.

Refractories at high temperatures. HOHLER. Russian Ceram. Res. Inst., *Publ.*, No. 12 (1928); *Refract. Jour.*, **4** [41], 160 (1929).—Research was carried out to determine the behavior of refractories at high temperatures. Details of the apparatus used are given, an electric furnace being used in order to obtain a uniform rise in temperature of 300° per hour. The author found that the temperature of the clay at which the first melting was observed appeared to be in inverse proportion to the degree of fineness of the grog. The results of a large number of experiments are recorded. E.P.R.

Casting of Corhart refractories. ANON. *Glass Ind.*, **10** [3], 74–75 (1929).—Photographs show a general view of the manufacturing plant of the Corhart Refractories Co., at Louisville, Ky., together with two interior views of the electric furnace in the operation of pouring and a portion of the inspection floor. A brief account of the first year's business is given, along with a description of the product and methods of producing the Corhart Electrocast Tank Block. E.J.V.

British Refractories Research Association. ANON. *Pottery Gaz.*, **54** [621], 413 (1928).—Investigations on drying have shown that wet clay pieces, in which the water content exceeds a certain limiting or critical value, invariably crack when heated in a saturated atmosphere, in circumstances which preclude any possibility of water evaporation from the piece itself. If the initial water content is below this critical value the cracking does not occur. The results appear to indicate that there is a relationship of significance in connection with the use of humidity driers between the moisture content of the clay and permissible drying temperatures. On the subject of the firing of refractories attention has been directed to (*a*) thermal efficiencies of the various kilns now in use; (*b*) the changes occurring in fireclay and silica goods at increasing stages

of heat treatment; (*c*) the effect of kiln atmospheres, rate of rise of temperature, etc., on these changes. Comparison of clay-bonded and lime-bonded silica brick in industrial furnaces showed that the clay-bonded silica brick are not so liable to spall as are the lime-bonded. Much attention has been paid to the determination of the thermal and mechanical properties of fire brick etc., and to the problem of giving satisfactory laboratory measure to the resistance of refractories to spalling, and to corrosion by molten glass, slags, coal ash, and other corrosive melts. The effects of texture, porosity, grog-grading, etc., on the mechanical strength of fire brick, siliceous and aluminous refractories at elevated temperatures have been examined. The effects of the crystalline composition of silica refractories on strength at high temperatures have also been elucidated. Reports on the insulation of kilns and of gas retort settings have been issued. The main work for the special benefit of the pottery industry is a general investigation on the sagger problem and on the possibility of minimizing the present financial losses caused by premature sagger failures on certain branches of the industry. E.J.V.

Flow of heat through furnace walls. R. J. SARJANT. *Pottery Gaz.*, **54** [621], 433 (1929).—The study of steady flow of heat through furnace walls is very complex in intermittent furnaces. Intermittency is the factor which must determine the character of the wall. In certain furnaces, particularly the in-and-out variety, the internal wall surface is an important function in the maintenance of a hot, radiating surface, and the capacity of the wall for the storage and dissipation of heat might govern the permissible rate of operation. The theoretical ideal is an inner wall of high refractoriness, sufficient in thickness only to carry the desired fluctuation of heat storage, and an outer wall of insulating material. The mechanical difficulties of constructing really thin refractory walls and the point of failure of the most effective insulating materials at temperatures above 800 to 1000°C would constitute the chief disabilities. Experiments carried out in connection with intermittent furnaces are described and the advantages of insulation are pointed out. E.J.V.

Effects of coal ash refractories. T. N. MCVAY AND R. K. HURSH. *Pottery Gaz.*, **54** [621], 458 (1929); abstracted from *Jour. Amer. Ceram. Soc.*, **11** [11], 868–73 (1928); see also *Ceram. Abs.*, **7** [12], 831 (1928). E.J.V.

Chromite from Rhodesia. ANON. *Eng. Min. Jour.*, **123** [8], 332 (1927).—The deposits are of 2 types: (1) irregular bodies, often lens-shaped, in serpentine and talc schists derived from metamorphism of basic and ultra-basic rocks of the Archean system, are located by trenching, and worked by quarry methods; (2) as regular seams, usually from 4 to 10 in. thick, in a body of basic and ultra-basic rocks of dike-like habit, 33 mi. long and 4 mi. wide. In places there are two or three seams separated by about 200 ft. of rock. A.J.M.

Future of bauxite. EDITORIAL. *Eng. Min. Jour.*, **123** [10], 393 (1927). A.J.M.

Sillimanite blocks for tank furnaces. ANON. *Glass*, **5** [11], 502 (1928).—Tests under actual working conditions with Alosil sillimanite blocks are described and illustrated. These blocks seemed very satisfactory. A.J.M.

Dolomite and magnesite. ANON. *Rev. mat. constr. trav. pub.*, No. 222, 68B (1928).—According to English and German usage, the carbonate of magnesium is called magnesite while the silicate is giobertite. In France the name giobertité is used to designate magnesium carbonate, and magnesite is the silicate. The fusion point of pure magnesia is 3000°C. The addition of 100% silica lowers the fusion point to 1400 to 1500°. The small amount of impurities in the raw material is sufficient to give bond and compactness. Magnesite deposits occur in Greece, Styria, and America. Deposits in India and in the Carpathians have not been exploited. Analyses of the materials from these various sources are given. Because of the scarcity of magnesium carbonate it is

fortunate that dolomite and calcareous magnesites can be used. These are found in England, Luxembourg, Italy, France, the Alps, and the Pyrenees. Typical analyses are given. The purest dolomites, originating from deposits of homogeneous material, are called primary dolomites; those resulting from the action of soluble magnesium salts on calcareous deposits are called secondary dolomites. Magnesia brick are used in glassmaking and in metallurgy; they are not used in cement burning because the magnesia is injurious. At times, metallurgical plants obtain dolomite in a partially fused form; this allows them to make special shapes as needed. Burned dolomite should contain at least 20% MgO and not more than 4% SiO_2, Al_2O_3, and Fe_2O_3 combined. Dolomite is burned in vertical or in rotary furnaces. By using an electric furnace a fused dolomite containing 98% MgO and less than 1% Fe_2O_3 is obtained; this fuses at 2600°C. A.J.M.

Failure of refractory materials at high temperatures. M. W. TRAVERS. *Chem. and Ind.*, **48,** 106–107 (1929).—Refractories are classified in two categories: (1) fireclay and siliceous materials with high bond, (2) silica, alumina, silicon carbide, or sillimanite materials with low bond. The first class fails when mullite is formed, leaving a matrix which is low in Al_2O_3 and SiO_2 and high in bases and therefore less viscous and less resistant to deformation under stress than the original. The second class, low in bond, fails or not, according to the piling of the particles; the bond tends to concentrate itself among the particles according to the principle of minimum volume. There is opposition between capillary forces and shearing stresses, and upon this the refractory character largely depends. H.H.S.

Use of refractories, stoneware, and porcelain in the chemical industry. FELIX SINGER. *Chem. Fabr.*, No. 48, 680–82; No. 49, 691–92 (1928).—S. defines these ceramic products and states where and why they (and others) are used for chemical ware. T.W.G.

Protection of refractories against corrosion. ANON. *Emaillewaren-Ind.*, **6** [6], 43–44 (1929).—While an open structure is advantageous for isolation and resistance to temperature change, it offers attack to slag, gases, and flue dust encouraging eutectics, solution, and failure. This can be avoided by using a fire resisting coating like "pyroment" which glazes the surface and is resistant up to about 1700°C. The importance of mortar having the same composition as the refractory is pointed out. T.W.G.

Deformation of refractory materials under load at high temperatures. E. KÖHLER. *Trans. Ceram. Res. Inst.* (Moscow), [12], 119 pp. (1928).—The various methods of determining the refractoriness-under-load of refractories, as described in the literature, are critically reviewed, and preference is given to the method which measures the degree of deformation under a given load under the influence of a gradually rising temperature. Apparatus and methods are described in detail. (*B.C.A.*)

Microstructure of Dinas. N. N. SMIRNOV. *Trans. State Expt. Inst. Silicates* (Moscow), **18,** 5–24 (1926).—Quartz changes in Dinas brick proceed as follows: (1) the first influence of the heat causes a breaking up of the quartz grains; (2) a change takes place from the quartz uniaxial to the biaxial; (3) quartz gradually changes into amorphous glass; (4) cristobalite is formed from the glass; (5) cristobalite gradually changes into tridymite. (*C.A.*)

Microstructure of refractory brick. N. N. SMIRNOV. *Trans. State Expt. Inst. Silicates* (Moscow), **18,** 25–32 (1926).—Considerable recrystallization takes place in most brick. Slender, long prismatic crystals appear, but they are poorly differentiated. The newly formed crystals resemble very closely the crystals of sillimanite. (*C.A.*)

Contraction of fire brick. I. V. SMIRNOV. *Trans. State Expt. Inst. Silicates* (Moscow), **21,** 29–39 (1927).—S. tested a series of 12 samples of different clays for the linear

and cubical decrease and porosity due to contraction when heated to 120°. These measurements were correlated with the plasticity of the respective clays. It was found that clays with a high contraction are the most plastic. (*C.A.*)

PATENTS

Treating refractory material. EARL LEESON HAUMAN. U. S. 1,702,942, Feb. 19, 1929. The method of treating a refractory material consisting in reactively heating progressively exposed surfaces of material to form a uniformly reacted mass.

Separation of refractory materials. EARL LEESON HAUMAN. U. S. 1,703,065, Feb. 19, 1929. The method of classifying bonded particles having included carbon, according to their crystalline size, consisting in grading bonded refractory material by particle size, in driving off the included carbon and in subjecting to gravity separation.

Refractory article. CHARLES FREDERICK LORENZ. U. S. 1,704,256, March 5, 1929. A crucible composed of tungsten powder sintered to tungsten wool.

Refractory resistor-supporting plate. FREDERICK E. OWEN. U. S. 1,705,094, March 12, 1929. As a new article of manufacture of the class described, a unitary self-supporting assembly consisting of a ceramic resistor-supporting plate and a layer of heat-insulating material located against one surface only thereof opposite to its heating surface and inherently cemented thereagainst.

Production of alumina. M. BUCHNER. Brit. 283,117, Jan. 3, 1928. Aluminiferous material, *e.g.*, clay, is heated for several hours at 80 to 100° with a deficiency of nitric acid to form basic aluminium nitrate; the solution is concentrated by partial evaporation, cooled to 0° to crystallize the basic nitrate, and the product heated *in vacuo* with water or stream. (*B.C.A.*)

Production of aluminium chloride. T. R. HAGLUND. Swiss 120,514, April 2, 1925. Aluminiferous material is fused with reducing agents and material containing sulphur to yield a product containing aluminium sulphide, and this is treated with chlorinating agents. (*B.C.A.*)

Terra Cotta

Organic agents as aids to the adhesion and suspension of glazes. E. S. FOSTER. *Jour. Amer. Ceram. Soc.*, **12** [4], 264–69 (1929).—One phase of glaze preparation and application that has received very little description deals with the use of organic adhesive and suspensive agents. This paper describes the kinds, sources, and uses of the principal organic agents. In addition, shop practice with reference to terra cotta glazes is described. To supplement these descriptions curves are given showing the comparative effects of organic agents on the bonding strengths of a ball clay-silica mixture.

White Wares

Some properties of glaze slips. EDWARD SCHRAMM AND ROBERT F. SHERWOOD. *Jour. Amer. Ceram. Soc.*, **12** [4], 270–73 (1929).—Data are presented for a fritted glaze and a raw porcelain glaze giving the relation between viscosity and specific gravity and p_H of glaze slip. The influence of grinding on the properties of the slip and of the fired glaze is also discussed.

Study of glaze fit. ANON. Bur. Stand., *Tech. News Bull.*, No. 142, pp. 18–19 (1929).—The coefficient of expansion of the glazes increases slightly with temperature. A list is given of tentative constants for various oxides which apply fairly well for the average linear coefficients over the range 20°C to the lower critical temperature. R.A.H.

Apparatus for wear tests on flooring materials. D. W. KESSLER. *Proc. A.S.T.M.* **28** [2], 855–67 (1929).—Due to the outstanding need for data on the wearing qualities

of flooring materials of the more permanent types, K. has worked out a simple abrasion apparatus in which the various testing conditions can be closely controlled. (1) Comparison of abrasion test results with results of service tests on identical materials shows a fair agreement and indicates that the testing apparatus gives valuable information as to wearing qualities. (2) Some evidence was developed that certain properties of materials other than abrasive hardness may influence the wearing qualities under service conditions. Toughness and strength as well as texture variations appear to be important considerations. (3) Humidity affects the abrasive action; that is, tests made during periods of high humidity indicate lower abrasive hardness values than tests made when the humidity is low. (4) Abrasion tests as well as actual wear measurements on 9 marbles, 8 limestones, and 5 slates indicate that marble is the most resistant, slate next, and limestone least. The denser limestones included in these tests show wear-resistance values more like those of marble. R.A.H.

Defects in hard porcelain and their remedies. E. KIEFFER. *Ber. deut. keram. Ges.*, **9** [10], 537–56 (1928).—A large percentage of the defects in hard porcelain can be traced directly to the raw materials or to the treatment of such material in the plant. Defects produced by impure materials, improper treatment of raw materials, improper drying and firing, and those defects produced by improper fit of glaze and body are discussed in detail. F.P.H.

Influence of titanium and iron on the color of a clay body. K. KOOMANIN. *Trans. Ceram. Res. Inst.* (Moscow), No. 6; *Keramos*, **7** [23], T1 (1928).—Dark blue bodies were obtained when titanium in the form of rutile was introduced into various body mixes and fired under slightly oxidizing conditions. Reducing conditions favored these colors. The intensity of the color was reduced when alkalis and alkaline earths were mixed with the bodies. F.P.H.

Science and the potter. F. G. PALMER. *Chem. and Ind.*, **48**, 190–91 (1929).—The importance of a study of colloids in clayworking and slip-casting is stressed. Pottery slip is not merely a suspension, but an emulsion in which the clay has entered into a kind of solution with water. The rearrangement of the clay molecules causes them to become fibrous or minutely fine needlelike crystals, called by Stern "fibro-crystals." H.H.S.

PATENTS

Composition of mold and method of casting pottery. JOHN D. WIGGIN AND MATHIAS M. REMMES. U.S. 1,690,708, Nov. 6, 1928. In the method of casting pottery, the steps including preparing a slip containing a soluble carbonate, preparing a mold, the material of which comprises plaster of Paris and a substance which will prevent a reaction between the carbonate in the slip and the calcium sulphate in the plaster of Paris, casting the slip in the mold, removing the cast, and firing it.

Electric strain insulator. RICHARD MAX REINHARDT. U. S. 1,702,315, Feb. 19, 1929. An improvement in electric strain insulators comprising an insulator body provided with an interior cavity open to the bottom end of the body and forming an abutment surface, a strain pin, one end of which is adapted for insertion in the cavity, a securing washer positioned at the inner end of the strain pin within the insulator cavity, such washer consisting of at least two separate oblong parts placed crosswise to each other and at least one of them at the side facing an adjacent washer part being provided with lugs straddling the last-mentioned washer part in such a manner that the lugs are positioned in substantially the same plane perpendicular to the strain pin as the ends of the adjacent washer part, the lugs and the ends of the adjacent washer part being shaped into the form of a substantially continuous abutment surface extending around the whole circumference of the securing washer.

Wall and floor tile. WILLIAM MCCOY. U. S. 1,702,912, Feb. 19, 1929. A tile provided on the rear bond-contacting face thereof with a plurality of panels in intaglio,

ribs intervening the intaglio panels, the exposed surfaces of the ribs being in the plane of the rear surface of the tile, and a web-like formation positioned within the boundaries of the panels and producing therein a multiplicity of pockets, whereby the pockets and the intaglio panels are adapted to receive bonding material for affixing the tile in position.

Dry-spot insulator. RUFUS GOULD. U. S. 1,703,853, Feb. 26, 1929. A dry spot insulator comprising a unitary body provided with an imperforate, unbroken, substantially conical surface of revolution, a centrally disposed aperture reëntrant from the base of the body, an annular recess surrounding the centrally disposed aperture and likewise reëntrant from the base of the body, an insulated conductor a portion of which is maintained in the recess and a plastic material impervious to moisture and substantially solid at normal temperatures in the recess and binding a portion of the insulated conductor therein.

Insulator mounting. BERNHARD KATZENBERGER AND THEODOR JANSEN. U. S. 1,704,005, March 5, 1929. (1) In a pin type insulator, an insulator body of ceramic material, the body having a perforation extending from one side thereof into the interior of the body, the walls of the perforation having longitudinal grooves with ribs of the ceramic body extending between the grooves, the ribs ending in the interior of the body at a height below the end of the perforation to provide an enlarged cavity in the interior of the body, a mounting pin for the insulator having a shank portion projecting through the perforation into the interior of the insulator and a head portion comprising a plurality of laterally projecting lugs at the end of the shank portion, the lugs corresponding to the grooves and being adapted to be inserted therethrough with the pin from outside of the insulator body into the cavity and rotated therein to bear against the ends of the ribs within the cavity, and wedge members fitting the grooves for locking the head projections against lateral rotation. (2) In a pin type insulator, an insulator body of ceramic material, the body having a perforation extending from one side thereof into the interior, the walls of the perforation having longitudinal grooves with ribs of the ceramic body extending between the grooves, the ribs ending in the interior of the body at a height below the end of the perforation to provide an enlarged cavity in the interior of the body, a mounting pin for the insulator having a shank portion projecting through the perforation into the interior of the insulator and a head portion comprising a plurality of laterally projecting lugs at the end of the shank portion, the lugs corresponding to the grooves and being adapted to be inserted therethrough with the pin from outside the insulator body into the cavity and rotated therein to bear against the ends of the ribs within the cavity, and a second set of projections on the pin corresponding to the projections on the head, the second set of projections being near the entrance into the perforation.

Sagger. ROBERT E. ANDERSON AND DANIEL P. FORST. U. S. 1,704,070, March 5, 1929. A sagger for supporting tile to be fired, which comprises upright plates spaced apart, a pair of bars spaced apart and rigidly secured to and connecting the plates near their upper edges, a pair of bars spaced apart and rigidly secured to and connecting the plates near their lower edges, and pairs of bars removably secured to the plates between the levels of the upper and lower pairs of bars.

Electric insulators. J. E. POLLOCK. Brit. 302,507, Feb. 6, 1929. Relates to insulators of the supporting or pedestal type in which the separate elements are connected by means of a yielding or elastic layer, and consists in using, for the elastic intermediate layer, fibrous material such as hemp, oakum, or pasteboard, impregnated with dextrine, lac, varnish, tar, or other binding material, in order to hold the fibers together. The insulator shown consists of three elements connected by an elastic layer which may consist of hemp, or of a pasteboard sleeve, impregnated with the binding material. The

surfaces separated by the elastic layer may be fluted, roughened, or threaded. In the case of a two-part insulator, one part may screw on to the other the impregnated material being introduced between the threads.

Equipment and Apparatus

Service to reclaim rare metal thermocouples. ANON. *Brick Clay Rec.*, **74** [5], 348 (1929).—Chas. Engelhard, Inc., Newark, N. J. has a process whereby it is able to reclaim rare metal thermocouples. They do not claim to restore the entire couple to its original condition. The wire may be too highly contaminated. Enough is restored to make this service profitable to the customer. E.J.V.

Heat-resisting steels. R. J. SARJANT. *Pottery Gaz.*, **54** [621], 433–34 (1929).—There is abundant evidence of the advantages of such materials in industrial practice. "Heat-resisting" steel means materials which combine resistance to heat, tenacity, ductility, high strength at elevated temperatures, and other qualities such as the capacity to be cast and a degree of malleability. A characteristic feature is a homogeneous solid solution known as austhenitic steel. Some of the manifold applications of these steels include mechanical stokers, utensils for the glass industry, recuperators, and even propeller fans used under high-temperature conditions. Other possible applications are mentioned. E.J.V.

Automatic decorating tunnel kiln. JOHN T. JANS. *Pottery Gaz.*, **54** [621], 447–48 (1929); reprinted from *Jour. Amer. Ceram. Soc.*, **12** [2], 107–10 (1929); see also *Ceram. Abs.*, **8** [3], 211 (1929). E.J.V.

Modern clay refining system. EDGAR W. BUCHANAN. *Mfrs. Rec.*, **95** [6], 86 (1929).—In western N. C., kaolin deposits are pure white. The usual method of mining is hydraulic. The mixture of crude clay and water is piped to the plant at the railroad. The separation is performed by a new device known as a bowl classifier which takes the place of settling troughs, washers, and beaters. No men are required to shovel out the tailings. This classifier consists of a settling box in the form of an inclined trough with the upper end open; in it are placed mechanically operated rakes or scrapers for the purpose of removing the quick-settling material from the open end. On the lower side of this settling box is superimposed a broad, shallow steel bowl 20 ft. in diameter, with stirring or thickening mechanism. The thickening is accomplished by the same process as the settling of the sand in the troughs. Revolving arms, to which plow blades are attached, sweep the bottom, pushing the quick-settling solids toward a central opening through which they fall to the bottom of the main classifier tank, and are subject to the action of the rakes. The feed enters the bowl through a shallow feed well near the center. Wash water is introduced near the center of the main tank. The clay is overflowed into a peripheral launder around the rim of the bowl. After the process of classification is complete the refined clay must be separated from the water. This is performed in large settling tanks. Here the water laden with clay is treated with sulphate of alumina, the clay is precipitated and the clear water discharged over the top. E.P.R.

Diamonds used in diamond drilling. ANON. *Eng. Min. Jour.*, **123**, [2], 47 (1927).—Black diamonds or carbonados are described in detail. Diamond drills are explained. A.J.M.

Jaw crusher as a sledger. W. T. W. MILLER. *Eng. Min. Jour.*, **123** [22], 876 (1927). A.J.M.

Jaw crusher as a secondary breaker. W. T. W. MILLER. *Eng. Min. Jour.*, **123** [25], 1007 (1927). A.J.M.

Gyratory as a sledging crusher. W. T. W. MILLER. *Eng. Min. Jour.*, **124** [1], 7 (1927). A.J.M.

Gyratory as a secondary breaker. W. T. W. MILLER. *Eng. Min. Jour.*, **124** [4], 131 (1927). A.J.M.

Evaluating grinding efficiency by graphical methods. W. H. COGHILL. *Eng. Min. Jour.*, **126** [24], 934–38 (1928).—A diagram is used for determining mean mesh and mean surface. The term "mean mesh" is stated by C. to be preferable to the term "average diameter" which is used extensively. If the percentages of weight of each size of material are regarded as parallel forces and are plotted on a lever arm hinged at any convenient point, such as 4-mesh, along the lever arm, the position of the resultant may be calculated. The sieves are equally spaced along the lever arm. This method is explained by the solution of a problem and by an illustration. The reduction ratio may be determined from the mean mesh. Mean surface is determined in a manner similar to that given for mean mesh with the difference that the lever arms are proportional to surface and since they are in a geometric series the zero must always be taken at the same point. The following conclusions have been reached: (1) the data in a screen sizing analysis may be laid off as hypothetical forces on a force diagram to determine mean mesh and mean surface; (2) for mean mesh the length of the lever arm is an arithmetic series; for mean surface the length of the lever arm is a geometric series varying inversely as the screen sizes; (3) the mean mesh may be used to determine the reduction ratio obtained by grinding, and the mean surface as the basis for calculating work done; (4) the law that the number of grains varies inversely as the cube of the size crushed to the cube of the size produced was checked by using two ores (chert, dolomite); each was sized on double Tyler screens. Since the law holds true that the number of grains varies inversely as the cube of the dimensions of the size crushed to the size produced, it is probable that the law holds true that the surface varies as the dimensions, and that sieves may be used to determine relative surfaces. A.J.M.

Protecting a jaw crusher against breakage. ANON. *Eng. Min. Jour.*, **126** [26], 1026 (1928). A.J.M.

Origin of lenses and microscopes. A. N. DISNEY. *Chem. and Ind.*, **48**, 126 (1929).—The Royal Microscopical Society has published an account, edited by D. and collaborators, of the origin and development of optical instruments. The earliest were spectacles to enable people to read, invented about 1280 in Italy. The microscope was invented about 300 years later at Middelburg, Holland, by Janssen, to whom is also ascribed the telescope, though claims on behalf of other contemporary Dutchmen have been made. H.H.S.

Types of storage structures. M. E. CROSBY. *Pit and Quarry*, **17** [10], 69–73 (1929).—A flexible and rapid handling storage system, handling the materials mechanically, is just as important a part of a modern up-to-date crushing plant as any other unit is. Producers are giving more and more thought to the question of building up supplies of their products to take care of a sudden or a periodic peak load or demand. The article deals with the structural features of various types of stone storage structures and as to how the differences in these features affect the construction cost of each type. Four types of storage structures are discussed, open, enclosed, and special outlays to take advantage of ground contour. All types are illustrated. The type and materials of construction are substantial and permanent throughout, permitting their operation over a long period of years with a minimum outlay for repairs, maintenance, or replacement. The cost of storage structures ranges from about $2 per ton total storage to $8 per ton. R.G.E.

The Thew handbook. ANON. *Pit and Quarry*, **17** [10], 92 (1929).—The Thew Shovel Co. has issued a handbook on the operation, care, adjustment and application of power shovels and excavating machines. It is published in loose-leaf form and can be kept up to date by future additions. It is divided into three sections, covering (1) all

operations of Lorain machines, (2) their care and adjustment, and (3) general excavating information, data, and tables pertaining to excavating work. R.G.E.

Economical design of plant conveyer systems. GEORG HELM. *Ber. deut. keram. Ges.*, **9** [10], 557–69 (1928). F.P.H.

Cottrell-Moeller process for precipitation of dust from gases. P. VER EECKE. *Bull. Féd. Ind. Chim. Belg.*, **7**, 293–305, 341–64 (1928).—The theory and history of the precipitation of mist and dust by the electrostatic field is summarized. There are three main types of precipitator: (*a*) that in which the electrodes are respectively a metallic tube and a wire hung axially, is heavy, but permits slow gas speeds and a maximum potential difference as the field is uniform, and is important in the metallurgy of nonferrous metals and in blast-furnace gas purification; (*b*) the type with curved sheets arranged between the discharging points, is lighter, permits of higher gas velocity, and gives less current loss, but the purification is not so good, the later forms providing for a horizontal gas flow and vertical collecting surfaces; (*c*) type consisting of screens of fine wire netting, is cheap and light, gives only moderate yields, and is suitable for the recovery of dusts of low value from large gas volumes. The degree of purity required for any gas is determined by economic considerations. Fractional precipitation may be arranged. The transformers usually work at 50,000 to 60,000 volts, but should be capable of resisting a 50 to 100% overload in case of short-circuits in the precipitator. The types of transformers and insulation problems are discussed. The power consumption of a Cottrell plant is 3 to 35 kw./1000 m.^{3} of gas. In the cement industry the Cottrell process has rendered recovery of potash possible. For complete volatilization a temperature of at least 1100° is necessary. Chlorides accelerate volatilization, but sulphates retard it. From 59 to 98% of the potash is recovered in a soluble form. In some cases it has been profitable to increase the output of potash by adding feldspar. In metallurgy Cottrell plants have application in the recovery of dusts, in the drying of slimes, and in the recovery of arsenic, copper, tin, mercury, lead, and zinc from roaster gases. These and other metals are also recovered from the gases from converters, cupelling furnaces, from the preparation of alloys, etc. A Cottrell plant serving for the lead, copper, zinc, and other dusts from a Belgian metal works is described in detail. It treats 20 m.^{3} of gas per sec. at 70° containing 2 to 3 g. of dust per m.^{3} The gases are humidified to 30 to 40%. (*B.C.A.*)

BOOK

Electric Drive Practice. GORDON FOX. McGraw-Hill Book Co., 1928, 421 pp., illustrated. Price $3.50. Reviewed in *Min. and Met.*, **10** [267], 174 (1929).—Successful application of electric motors to machine driving requires, among other things, knowledge of the requirements of the machinery to be driven and consideration of every aspect of its motion that affects the drive. This book is intended to give this information for those classes of machinery which are in common use in many industries. It discusses motor drives for blowers, compressors, pumps, cranes and hoists, elevators, mine hoists, machine tools, and industrial traction. The elements of load are evaluated and the factors that affect the determination of the size of motor for each kind of machine are pointed out. The functions of the different machines, the laws governing their action, and their distinctive requirements are enumerated, assisting the reader to select the proper motor for any given purpose. F.P.H.

PATENTS

Apparatus for making ceramic articles. THOMAS S. CURTIS. U. S. 1,703,871, March 5, 1929. In apparatus of the class described, in combination, a mold, a source of supply of ceramic slip, means to conduct the slip from the source to the mold, and means to maintain the slip in agitation at the source, in the conducting means, and in the mold, during the operation of flowing the slip to and into the mold.

Method of preparing refractory metals. JOHN W. MARDEN, THOMAS P. THOMAS, AND JOHN E. CONLEY. U. S. 1,704,257, March 5, 1929. Method of producing rare refractory metals such as uranium, thorium, etc., from their difficultly reducible oxides which comprises heating to a reacting temperature such oxides, an alkaline earth metal and an alkaline earth halide.

Refractory gun. GERALD P. MCMANAMNA. U. S. 1,704,623, March 5, 1929. In a sprayer for plastic material, a container provided with a head constituting a surge chamber, the head having converging walls terminating in a tubular elongate projection chamber arranged transverse of the axis of the container, the surge chamber and the projection chamber being connected by an elongate opening, in combination with means for elevating the plastic material in the container into the head, and means for applying fluid pressure to project the material from the projection chamber.

Classification of materials by elutriation. LEONARD ANDREWS. U. S. 1,705,351, March 12, 1929. A method of classifying material by elutriation, the method consisting in projecting a mixture of the material with water into a body of water that is flowing upward at a less velocity than the downward projected mixture, whereby the heavier particles of material in the mixture will be projected to the bottom of the body of water while lighter particles in the mixture will be carried upward by the rising water, dividing the heavier particles into separate accumulations thereof, washing the accumulations of heavier particles by clean water caused to flow upward through them so as to remove lighter particles attached to the heavier particles and carry such lighter particles upward into the rising body of water and allowing the heavier and cleaned particles to fall through the washing water.

Kilns, Furnaces, Fuels, and Combustion

Classification of North American coals. A. C. FIELDNER. Bur. Mines, *Information Circ.*, No. 6094 (Jan. 1929).—(1) Coal should be classified primarily on the basis of its intrinsic chemical and physical properties. These properties involve the origin, composition, and constitution of the coal. (2) Use classification should be secondary to scientific classification and should be correlated with the scientific classification as far as possible. (3) Scientific classification depends on 2 primary factors: (*a*) the composition and type of the original coal forming vegetation, (*b*) the degree of metamorphism or coalification of the vegetable residue. (4) The first factor is described broadly in the type of coal, as xyloid canneloid, or boghead; the second factor in the progressive rank of the coal as expressed in the series from lignite to anthracite. (5) The criteria to be considered for classifying under these two general factors are proximate and ultimate analyses, calorific values, microscopic examination, extraction with solvents, reaction with reagents, and destructive distillation. R.A.H.

Coke and by-products in 1926. F. G. TRYON, H. O. ROGERS, AND H. L. BENNIT. Bur. Mines, *Mineral Resources of the U.S.*, Part II, 587–675 (1926).—Three influences dominated the coke market in 1926: sustained activity in the iron and steel industry; the anthracite suspension of 1925–26; and the British miners' strike. Statistics of principal facts of the coke industry in 1926 are presented in tables. The coal producing industries are listed and complete definitions of the various types of coke made are given. R.A.H.

Spontaneous combustion of stored coal. A. T. WARD. *Blast Fur. Steel Plant*, **17** [2], 298–301 (1929).—The causes leading up to the ignition of bituminous coal in piles are reviewed and practical hints are given for safeguarding against consequent losses. F.P.H.

Unsaturated hydrocarbons in coal gas. ANON. Fuel Research, *Tech. Paper*, No. 19; *Gas Age-Rec.*, **63** [3], 72 (1929).—The need for a method of more accurately deter-

mining these hydrocarbons is mentioned. A method is described for the determination of ethylene, propylene, butadiene, and butylene in gas. These represent over 90% of the gaseous unsaturated hydrocarbons present. The new method involves the separation of the unsaturated gases as their bromine compounds and the regeneration of the ethylene, propylene, and butylene from the latter by the action of a zinc-copper couple. The resulting gas is then analyzed by absorption of the propylene and butylene by 87% sulphuric acid, and combustion of a further quantity of the gas over copper oxide at a temperature of 700°C and determination of the volume of carbon dioxide produced. The method is applied to low temperature coal gases, to high temperature gases from horizontal retorts and vertical retorts. The results show an increase in the quantity of all olefine hydrocarbons with rising temperature of carbonization within the range of 400 to 700°C. The proportions of the three olefines in the gas produced at 600°C are not unlike those produced by the carbonization of a bituminous coal mixture in the low temperature vertical retorts, although the quantities per ton of coal are only about one-half in each case. F.P.H.

Economics of high pressure natural gas pipe lines. P. McDONALD BIDDISON. *Gas Age-Rec.*, **61** [4], 103–107 (1929).—For the movement of large quantities of gas the sizes of pipe which manufacturers can now make in quantities sufficient for the speed of construction required are too small. To keep the pipe size within the limits of pipe which can be had in quantity and thereby avoid excessive premiums on pipe and cost by delays in construction, higher pressures are being resorted to. It has, as a consequence, been suggested by many that even in cases of smaller quantities economies might be effected by using higher pressures, as much as 1000 or 1500 lbs., accomplishing the desired result by pipe of much smaller diameter. It is primarily with the possibility of effecting economy by the use of such higher pressures that this paper deals. F.P.H.

Natural gas. CLAUDE C. BROWN. *Gas Age-Rec.*, **63** [1], 4–6 (1929).—The article contains information concerning natural gas production, distribution, utilization, conservation, and the present status of the industry. F.P.H.

Regenerative complete gasification system. A. K. COLLINGE. *Gas Age-Rec.*, **63** [1], 7–8 (1929).—The system of complete gasification, by which the coal is completely gasified in one vessel, is similar to other systems in that the gas producer consists of a carbonizing chamber superimposed upon a water-gas generator; but here the analogy ceases. Only about one-third to one-half of the total heat required to carbonize the coal can be obtained from the water-gas, and the deficiency is made up by recovering the heat of the waste gases during the blow period in a regenerator, and transferring it direct to the coal during the "run" by circulating a stream of gas through the regenerator and thence through the coal in the carbonizing chamber. The sensible and latent heat of the blow gas is thus used to carbonize the coal by internal heating, and in actual practice there is always far more heat available than is required. F.P.H.

Water-gas and producer-gas reactions. ANON. *Gas Age-Rec.*, **63** [1], 10 (1929).—The technical and metallurgical importance of those chemical reactions responsible for the production of water-gas and producer gas, which are fundamental in all processes involving gaseous and solid carbonaceous fuels, emphasizes the need for data of the highest possible reliability concerning these processes. Two methods of study are possible; (1) direct determinations of equilibria involving steam, hydrogen, carbon, carbon monoxide, and carbon dioxide, using suitable catalysts, (2) indirect calculations from reduction equilibria of certain oxides, especially those of iron, tin, copper, etc. Unfortunately, these independent methods, when compared, show discrepancies of considerable magnitude. Previously reported work in reviewing the specific heat of the gases involved at high temperatures, permits calculations to be made, lessening somewhat these discrepancies, and correlation of existing data has been completed with re-

sults which correspond to a 15% error in the chemical equilibria involved. Although the numerical results of this work show a distinct improvement upon previously accepted figures, the chief importance of the values obtained may be to show with considerable definiteness the still existing errors in some of the data. F.P.H.

Synthetic hydrocarbon processes. W. W. ODELL. *Gas Age-Rec.*, **63** [2], 37–41 (1929).—For many years it has been known that the chief components of water-gas would react chemically under proper conditions to form methane. In 1903 a U.S. patent was issued for a gas-making process which included the synthetic production of methane. More recently the studies of numerous investigators have shown that besides methane it is possible to produce other paraffins, olefines, and additional materials adaptable for enriching water-gas or for other uses. Although the details of various tests and experiments are recorded elsewhere, familiarity with the general procedure of the laboratory investigations from which important deductions have been made is pertinent to the understanding of the conclusions. The practice has been to cause carefully purified $CO + H_2$, mixed in predetermined proportions, to pass under a definite pressure into contact with a particular catalyst, which is usually retained under controlled temperature conditions in a suitable (usually a very small) tube. The rate of flow of the gaseous mixture is controlled and its composition and volume before and after passage through the catalyst tube are determined. Some of the reactions which may thus occur, and which are of interest in relation to the gas industry, are as follows:

$CO + 2H_2 = CH_4 + H_2O$	(1)	Reactions occur at atmospheric pressure in the presence of nickel catalyst. Optimum temperature = 330°C
$2CO + 2H_2 = CH_4 + CO_2$	(2)	
$CO_2 + 4H_2 = CH_4 + 2H_2O$	(3)	
$CO + 2H_2 = CH_3OH$	(4)	Reaction (4) occurs at very high pressure in the presence of zinc oxide-zinc chromate catalyst
$2CH_3OH = CH_3OCH_3 + H_2O$	(5)	

F.P.H.

The Honigmann-Bartling carbonizing process. DAVID BROWNLIE. *Gas Age-Rec.*, **63** [3], 69–70 (1929).—A highly interesting new German process is the "Honigmann-Bartling," in which connection there are several patents, the first having been taken out in 1920. The principle of the retort is essentially that of a very large horizontal cast-iron ring table, with a large hollow center portion; this ring rotates continuously and very slowly, driven by means of gearing, forming the carbonizing surface. In cross-section, however, the ring is not flat on the surface but curved slightly, with the highest point in the center, and is heated underneath all around by a large circular firebrick channel or shallow chamber filled with small pieces of fire brick, which has at the bottom, at regular intervals, a series of large vertical gas burners operated with an air blast. In this way the whole mass of firebrick pieces, as well as the surrounding setting, is raised almost to incandescence, distributing the heat uniformly to the horizontal curved ring plate above. The latter has spread all over its surface a thin layer of the raw lignite or other fuel, fed in continuously from a hopper, and the charge is carbonized as the ring table travels round, the residual low temperature fuel in a fine state of division being scraped off at the end of the travel, while the hot metal surface immediately passes under the hopper again and is supplied afresh with raw fuel. A large experimental retort on these lines has been operating for some time past in Germany and the results are very satisfactory. F.P.H.

Electric kilns. ANON. *Nature*, **122**, 1011 (1928).—Experiments on electrically heated kilns for ceramic use have been in progress for the last ten years but only in recent times have improvements been made which give promise of making them commercially practical. A small reduction in the price of electricity is all that is now necessary. The purity of the atmosphere obtainable makes the electric furnace ideal for decorated pottery. According to S. R. Hind in *World Power* for Dec., "Better results can be obtained in half the time required for a coal-fired muffle kiln. The control of temperature is

exceptionally accurate and the available part of the total energy consumed is high when compared with other fuels." C.R.A.

Combustion in gases. ANON. *Nature*, **123**, 30 (1929).—The article is a discussion of the various papers which have recently appeared on the subject of flames. C.R.A.

Manufactured gas leads all fuels. ANON. *Glass Ind.*, **10** [3], 56 (1929).—The manufactured gas industry in 1928, led the fuel industries of the country in sales, according to the latest analysis made public by the American Gas Assn. The following table of preliminary estimates prepared and given out by the industries themselves indicates the percentage increase or decrease in fuel sales for 1928 as compared with 1927:

Coke	+2
Bituminous coal	−4.8
Anthracite coal	−5
Crude petroleum	+1
Manufactured gas	+3.8

The gain in manufactured gas is in the face of a change from manufactured to natural gas. E.J.V.

New method of direct firing glazed ceramic bodies. F. A. WHITAKER. *Pottery Gaz.*, **54** [621], 450–52 (1929); reprinted from *Jour. Amer. Ceram. Soc.*, **12** [2], 87–95 (1929); see also *Ceram. Abs.*, **8** [3], 207 (1929). E.J.V.

Furnace control. C. B. GORDON-SALE. *Mech. World*, **85** [2196], 95 (1929).—Methods of control of gas and air mixtures in furnaces so as to eliminate fuel waste are discussed. E.P.R.

Clay firing. ANON. *Prz. Chem.*, pp. 176–84 (1928); *Refract. Jour.*, **4** [41], 160 (1929).—The various factors which influence the firing of clay have been studied. Methods for volatilizing the sulphur content and reducing the iron and aluminium content are given. The relative influence of the sulphur and moisture content on the rate of dehydration have also been studied. E.P.R.

Method for the photographic examination of moving flames. A. G. WHITE. *Jour. Chem. Soc.*, pp. 1159–61 (1928). A.J.M.

Studies in the composition of coal. I. Oil-yielding constituents. R. H. HOLROYD AND R. V. WHEELER. *Jour. Chem. Soc.*, pp. 2669–77 (1928). **II. The rational anaylsis of coal.** W. FRANCIS AND R. V. WHEELER. *Jour. Chem. Soc.*, pp. 2967–78 (1928). **III. The active decomposition point of coal.** R. H. HOLROYD AND R. V. WHEELER. *Jour. Chem. Soc.*, pp. 3197–3203 (1928). A.J.M.

World production of fuel. ANON. *Chem. News*, **138**, 104 (1929).—The demand for solid fuel increases very slowly. The production last year was 1.45 billion tons, and 15 years ago it was 1.35. Two causes for this are (1) the growth of waterpower, which has increased from 29 to 40 million H.P. installed in 5 years, and (2) the production of petroleum, which has now passed $1^1/_4$ billion barrels per annum. But a third cause is the more scientific use of coal. Plants are now fitted with boilers that can utilize wash settlings where formerly screened bituminous coal was used. H.H.S.

BOOK

Producer Gas Economics. Wellman-Seaver-Morgan Co. (Cleveland, O.) *Bull.* No. 91.—A new 32-page bulletin containing valuable data on producer gas economics, comparisons of producer gas with other fuels, analyses of coals and a description of the W-S-M Type L mechanical gas producer with the recently developed Wellman double-bell fuel feed. The cover bears a colored sectional view of the Type L producer and numerous illustrations and descriptions of the machine are given. Examples of the results obtained by this equipment in glass factories and other plants are shown. Producer gas is compared with fuel oil and natural gas. A heat balance of hot raw producer

gas made in a Wellman-Seaver-Morgan producer is given. Formulas for flow of gases, combustion data, heat of combustion of producer gas and other data are given. Reviewed in *Glass Ind.*, **10** [3], 77 (1929). E.J.V.

Geology

Electrical methods of geophysical prospecting. A. S. EVE AND D. A. KEYS. Bur. Mines, *Tech. Paper*, No. 434 (1928).—In a previous publication the writers gave a brief and elementary account of the principles involved in geophysical prospecting. Some of the methods described have been verified by experiment and the results are reported in the present paper. The results show that the existence of an ore body and a certain amount of valuable information as to its distribution can be obtained with equipment that is procurable with comparative ease by the practicing mining engineer. A proving ground for these tests was selected at Caribou Mt., Colo. A magnetic survey and electrical surveys by many simple and direct methods were made over a selected area. The use of the torsion balance was also investigated in this region. The magnetic and electrical surveys agreed very satisfactorily in locating the ore body; the various electrical surveys also give concordant results. Although the seven electrical methods discussed all gave indication of ore bodies, some were much more easily interpreted than others. R.A.H.

Properties, mining, preparation, and utilization of bentonite. C. W. DAVIS AND H. C. VACHER. Bur. Mines, *Tech. Paper*, No. 438, 51 pp. (1928); *Eng Min. Jour.*, **123** [12], 495 (1927).—Bentonite contains 75% or more of the crystalline claylike minerals montmorillonite or beidellite. The various known deposits are discussed by states. From a consideration of the behavior of the gel of Wyo. bentonite, one would judge it to be an inorganic, hydrophilic colloid. Material such as the sample of bentonite from Tex. and N. Mex. should cause no trouble in wet drilling except through caving of the wet walls since the increase in volume is small and the resulting product is not pasty; however, certain bentonites swell markedly in water and are known to cause the difficulties enumerated. The tests described show that lubricating oil, kerosene, or gasoline could be used to replace water in wet drilling through bentonites to prevent swelling and breaking down; however, water would have to be excluded to prevent the formation of emulsions. Bentonites are classified as (1) alkali, (2) alkali subbentonite, (3) alkali-earth, (4) alkali-earth subbentonite. The commercial importance of bentonite may depend on its physical condition (marked adsorption, absorption, or coalescence and its effect on emulsions, suspensions, and surface tension)or on its chemical reactivity or on both. The various uses of bentonite discussed are: As a filler, binder, or plastic in connection with paper, oilcloth, curtain cloth, cordage, rubber, ceramics, Portland cement, road building, lubricating greases, putty, foundry work, phonograph records and electrical insulation; pencil leads, crayons, pastel colors, plasters, paste glue, size, and as a bonding agent in stove and shoe polishes; as adsorbent, emulsifier, or peptizer in soaps and detergents, de-inking printed papers, refining of oils and fats, horticultural sprays, animal dips and insecticides; use in paints, enamels, and inks; wood dips, roofing preparations, and waterproofing; coal-mine dusting, desiccating agent, removing water from petroleum, manufacture of dynamite and as an absorbent of miscellaneous such as dyes, pigments, etc. Bentonite is used as a chemical reagent in water softening, treatment of molasses and as an aid in soil fertility. Bentonite is used as a medicant and cosmetic in drugs, as an antiphlogistic and in face creams. The report brings practically all present day knowledge on bentonite under one cover. R.A.H.

Pseudo-cubic quartz crystals from Artesia, New Mexico. W. A. TARR AND JOHN T. LONSDALE. *Amer. Mineral.*, **14** [2], 50–53 (1929).—Quartz crystals are among the most wide-spread of crystal forms, especially the hexagonal prism terminated by the

two rhombohedral forms *r* and *z*. Quartz crystals consisting dominantly of but one of the rhombohedral forms are rare and known from relatively few localities. This paper describes a new locality, near Artesia, N. Mex., where rhombohedral quartz crystals of large size are to be found. These crystals closely simulate cubes. They occur with other crystals of more common habit, and here, and in numerous other localities in southeastern N. Mex., where the common quartz crystals occur, they are known as "Pecos diamonds." F.P.H.

Temperature of magmas. ESPER S. LARSEN. *Amer. Mineral.*, **14** [3], 81–94 (1929).—Evidence concerning the temperatures of magmas is summarized: (1) Rhyolitic magmas have lower temperatures than basaltic magmas. (2) Direct measurements of temperatures at volcanoes give less satisfactory data than might be expected. Measurements of the basaltic magmas at Kilauea vary from 750 to over 1200°, those at Vesuvius vary nearly as much. (3) The melting temperatures of minerals that have crystallized from a magma yield only maximum temperatures. Some biotites must form below 850°. (4) The inversion temperatures of silica show that some basalts and most rhyolites and quartz latites are nearly completely liquid at temperatures below 870° and probably all magmas crystallize above 573°. (5) Common hornblende inverts to basaltic hornblende at a temperature of 750°. Hence most hornblende rhyolites and quartz latites and many andesites crystallize below that temperature. (6) Since the inversion of quartz inclusions to tridymite or cristobalite is very rare, and this inversion takes place without a flux at an appreciable rate at 1250°, very few magmas have so high a temperature. (7) The lack of fusion of most granitic and arkose inclusions indicates a temperature below about 1150° but partial or complete fusion might take place at a much lower temperature in the presence of mineralizers, even the mineralizers in the crystallized granite or arkose. The conclusions seem to be justified that some basaltic magmas have temperatures below 870°, many are below 1000°, very few are as high as 1260°, and probably most are not far from 800 to 900°. Rhyolitic magmas have lower temperatures. All are above 573° and below 870°. Nearly all are below the temperature of decomposition of biotite (about 850°) and that of common hornblende (about 750°). Probably most rhyolitic magmas have temperatures near 600 or 700°. F.P.H.

Nonmetallic minerals. ANON. *Rock Prod.*, **32** [5], 90 (1929).—At the Inst. of Mining Engineers, C. W. Ryan, mining engineer and geologist, Lynchburg, Va., gave a sketch of the geology of the soapstone deposits of the Piedmont section of Va., with a description of the methods of prospecting, developing quarries, quarrying and milling methods. W. M. Weigel, mining engineer, Missouri Pacific Ry., St. Louis, Mo., described the economic deposits of barite in Mo. and the methods of recovery. H. E. Nold, professor of mine engineering, Ohio State University, explained "the fundamental principles involved in examining a clay deposit for both quality and quantity, and in operating a clay mine, either open-pit or underground, so that the best quality of finished material can be made from the raw material available." George C. Banner, mining engineer, Little Rock, Ark., described three bentonite deposits in southern Ark., suggesting that there may be large quantities of this material in the locality, easily mined and of probable future importance. F.P.H.

Geological excursion in the field of clays and kaolins. JOHANNES FISCHER. *Tonind. Ztg.*, **52** [61], 1231–33; [63], 1272–74 (1928).—Geological formation of clays is discussed. F.P.H.

Variations of the word "feldspar." NILS ZENZEN. *Geol. Foren. Stockholm Forh.*, **47**, 390–405 (1926); *Mineral. Abs.*, **3** [10], 468 (1928).—The origin of the name feldspar is discussed. The form "feldtspat" was first given by D. Tilas (*Akad. Handl. Stockholm*, **1**, 199 (1740)). He gave no derivation, but no doubt the name has reference to the pres-

ence of the spar (spath) in tilled fields (Swedish, feldt), the soil of which was from the disintegration of rapakivi granite. The form "feldspath" was the German equivalent, and "felspar" is based on R. Kirwan's supposition (1794) that the name was of German origin and derived from "fels," rock. F.P.H.

Feldspar mining. F. C. LINCOLN. *Eng. Min. Jour.*, **124** [1], 5 (1927).—Occurrence of high-grade potash feldspar in the pegmatites of the Black Hills of S. D. has been known for years but high freight rates formerly precluded its shipment at a profit. In 1923 favorable rates were secured. The potash feldspars of the Black Hills are white and pink in color. They are composed mainly of orthoclase or of microcline, with small amounts of albite, and usually contain a little accessory muscovite, quartz, and amblygonite. They fuse at cones 7 to 9 (1270 to 1311°C) to a good color. Chemical analyses of some of these feldspars are given. The phosphorus content is much higher than in other potash feldspars and this recommends them to the enamel industry. The feldspar occurs in particles of various sizes, from fine grains intimately mixed with quartz and accessory minerals and without economic value, to coarse masses sometimes of enormous size, which may be mined at a profit. Great variations occur in the size of the feldspar particles within the same pegmatite dike, so that portions of a dike may contain valuable feldspar and other portions may be worthless. By-products such as columbite-tantalite, beryl, and lithiophilite-triphylite are saved from some mines and bring good returns. A.J.M.

North Carolina feldspar mining. ANON. *Eng. Min. Jour.* **123** [8], 336 (1927).—The Spruce Pine feldspar district of N. C. covers an area 12 mi. in width by 32 mi. in length in Yancey, Mitchell, and Avery counties. The first carload of crude feldspar was shipped from this district in 1911. Total shipments from the district in 1926, were around 80,000 T., or about 40% of the feldspar mined in this country. Most of the deposits show considerable variation in physical and chemical properties; even in a single deposit this may hold true. Mica, quartz, and other foreign materials occur irregularly. A typical analysis is: SiO_2, 67%; Al_2O_3, 18; K_2O, 12; Na_2O, 2.5. The vein is a giant pegmatite. The separation of pure feldspar by selective blasting is partially accomplished in the mine and completed by hand on the picking belt at the mill. A high-grade soda feldspar (albite) of the following composition is also mined: SiO_2, 71%; Al_2O_3, 18; Na_2O, 8; K_2O, 2. A.J.M.

Feldspar deposit. B. M. SHAUB. *Econ. Geol.*, **24** [1], 68–89 (1929).—A number of deposits are being operated in the U.S., the material in every case being obtained from pegmatites, most of which occur in schists or gneisses, but rarely in other types of metamorphic rock. The deposit described in this paper is located in northern New York state, 3.9 miles southwest of DeKalb Junction, St. Lawrence County, and seems worthy of description because of its unique geological occurrence and mineralogical associations. E.P.R.

A new borate mineral. H. S. GALE. *Eng. Min. Jour.*, **123** [1], 10 (1927).—This new mineral, for which the name "Kernite" is proposed, has the composition corresponding to $Na_2B_4O_7 \cdot 4H_2O$. It was discovered in Kern County, Calif. One pound of kernite will yield 1.39 lb. of borax and all that is necessary to produce borax is to dissolve the mineral in water and allow it to recrystallize. Kernite is said to occur in a massive ledge 75 ft. thick, and in a very pure form. A.J.M.

The gypsum industry at Caledonia, Ontario. W. A. GORDAN. *Eng. Min. Jour.*, **123** [9], 374 (1927). A.J.M.

Resources of Newfoundland. D. E. WOODBRIDGE. *Eng. Min. Jour.*, **123** [10], 397–400 (1927). A.J.M.

Bauxite deposits in the U. S. G. I. ADAMS. *Blast Fur. Steel Plant*, **17** [2], 325 (1929).—After summarizing the literature on the occurrences of bauxite in the Tenn.-

Ga.-Ala. field, A. concludes that they are all approximately of the same age, Eocene, and "were formed under peculiar physiographic and climatic conditions," which, are those postulated for the lateritic alteration of rocks. The bauxite deposits of the U.S. are in central Ark., northern and east-central Ala., northwestern and west-central Ga., northeastern Miss., and eastern Tenn. F.P.H.

Formation of bauxite. L. T. EMORY. *Eng. Min. Jour.*, **123** [19], 771 (1927).—Tropical climatic conditions apparently are essential for the formation of bauxite. Known deposits seem to be of recent geological origin, having been formed since the Cretaceous period. It is not at all certain that kaolin is an intermediate product in the decomposition of the feldspar fraction of pegmatite dikes to form bauxite. E. is of the opinion that the decomposing rock forms bauxite or kaolin according to conditions. Bauxite may be of sedimentary origin. A.J.M.

Pegmatite mining in the Black Hills. F. C. LINCOLN. *Eng. Min. Jour.*, **123** [25], 1003 (1927).—Among the minerals discussed are andalusite, microcline, muscovite, orthoclase, and quartz. A.J.M.

World production of diatomite. ANON. *Eng. Min. Jour.*, **126** [25], 985 (1928).—The diatomite output of the U.S. in 1926 totaled 79,030 metric tons. Algeria was second with 7,931 T. exported; Germany was third with 5,919 T. exported. Diatomite deposits of commercial size occur in many European countries. Kenya, East Africa, contains extensive deposits, but distance from markets renders these of no present value. At several other places in Africa, Oceania, and the Americas there are deposits. Diatomite is used as an insulator against heat and sound, a filter aid and filtering medium, a filler in rubber and cement, an inert base for dynamite, and an abrasive. A.J.M.

Diatomite in Arizona. C. TRISCHKA. *Eng. Min. Jour.*, **127** [1], 13 (1929).—Microscopically there is no difference between the diatomite of Ariz. and that of any other place. A typical analysis shows 85.75% SiO_2; 3.50% Al_2O_3; 1.50% Fe_2O_3; 2.0% CaO; 5.0% H_2O. It is white to cream in color, dull in luster, light in weight. It will absorb 1.5 to 2 times its weight of water and weighs when dry 18 to 20 lbs. per cu. ft. It is found in bedded deposits in the Pleistocene or Pliocene (late Tertiary) along the banks of the San Pedro and Gila River system. Four important deposits are described. A.J.M.

Reaction between monohydrated ferric oxide and hydrogen sulphide at 100°C. T. G. PEARSON AND P. L. ROBINSON. *Jour. Chem. Soc.*, pp. 814–23 (1928).—The conclusions are: (1) the primary reaction leads to the production of ferric sulphide, (2) the free sulphur is due to oxygen adsorbed on the surface of the oxide which appears to be unreduced by long washing with hydrogen, and (3) some ferric sulphide decomposes with the formation of equimolecular proportions of disulphide and monosulphide. A.J.M.

South Dakota as glass manufacturing center. ANON. *Amer. Glass Rev.*, **48** [19], 32–33 (1929).—The abundance of basic raw materials for glassmaking in S. D. is described. Quartz, flint, and quartz sands are found in the Black Hills and the white quartz at Keystone is rare and of special value in glassmaking. There is enough limestone to supply the needs of the country for centuries to come. Oxide of lead is found at Spokane and Galena. Marble dust can be obtained at the marble quarries near Rapid City. Manganese is in evidence in the sand beds of the Missouri River and there is evidence of potential resources of this metal in the state. Potash is in many of the Black Hills minerals and can be also obtained from wood ashes, which in turn can be secured from the fallen timber in the forest region. Lithia pegmatite, used for toughening the translucent glassware, is found in abundance at Custer, Pringle, and other places in the Black Hills. Feldspar is found in large deposits. E.P.R.

Potash in Poland. ANON. *Chem. and Ind.*, **48**, 138 (1929).—The Galician mines

at Kalusz and Stebnik produce 250,000 T. (24% K_2O) or potash yearly. The minerals are sylvinite, langbeinite, and kainite. The deposits differ from those of Stassfurt and Alsace in containing a clay which settles with difficulty. Increase of production has followed on the use of circulatory digestors and baffle clarifiers, and the addition of coagulators. H.H.S.

Molybdenum in Tasmania. ANON. *Chem. and Ind.*, **48,** 169 (1929).—An important discovery of Mo ore has been made at Mount Remus in the west coast district of Tullah. The ore body, along a half-mile opening, is said to contain a very high proportion of Mo. H.H.S.

Asbestos in Australia. ANON. *Chem. and Ind.*, **48,** 169 (1929).—The Australian and General Asbestos Co. has acquired properties at Sherlock, in the Pilbara district of western Australia. It is said that the deposits will provide some of the finest fiber ever placed on the market. H.H.S.

Minerals and mining industries of Czechoslovakia. J. G. F. DRUCE. *Chem. and Ind.*, **48,** 189–90 (1929).—In mineral resources the republic ranks among the first countries in Europe. It possesses every useful metal except Pt and is famous for Karlsbad kaolin; coal, lignite, iron ore, mineral oils, salt, graphite, and garnets are worked in considerable quantities, some of them since prehistoric times. It has 75% of the former Austro-Hungarian chemical industries, although its area is only 22%, and its population 26%, of the old empire. H.H.S.

Talc. F. A. WESTBROOK. *Pit and Quarry*, **17** [10], 63–68 (1929).—The geologic distribution, chemical nature, uses, and mining and manufacture of talc are discussed. The plant of the Vermont Talc Co. is described. R.G.E.

Geology: its study and relationships. BRADFORD WILLARD. *Sci. Monthly*, Jan., pp. 52–56 (1929).—The relationships of these branches are given; physiography, geography, meterology, climatology, economic geography, historical geology, paleontology, stratigraphy, sedimentation, mineralogy, crystallography, petrology, petrography, prospecting, economic geology, structural geology, dynamical geology. T.W.G.

Bauxite, laterite, and red clay. T. KORMOS. *Bányás Kohás Lapok*, **61,** 32–35 (1928).—Sharp distinction should be made between genetically primary and secondary bauxite occurrences. New examinations of bauxite occurrences in the Bakony mountains, Hungary, showed that the original chemical character of primary bauxite changes during geologic transferring. When evaluating a bauxite occurrence, both chemists and geologists should be consulted. (*C.A.*)

BOOKS

The Magnetic Methods of Applied Geophysics. HANS HAALCK. Gebruder Bornträger, Berlin (1927). Price 12 M. 150 pp., illustrated. Reviewed in *Econ. Geol.*, **23** [4], 461–62 (1928). E.P.R.

A Shorter Physical Geography. EMMANUEL DE MARTONNE. Reviewed in *Econ. Geol.*, **23** [4], 462–63 (1928). Translated by E. D. Laborde. 338 pp., illustrated. Alfred A. Knopf, New York (1928). E.P.R.

Investigations Concerning Sedimentary Clays. V. M. GOLDSMITH. Reviewed in *Econ. Geol.*, **23** [4], 463–66 (1928).—The investigations were made in the Mineralogical Institute of the Univ. of Oslo. The term "composition of a clay" includes: (*a*) chemical composition; (*b*) mineralogical composition; and (*c*) mechanical composition (grain-size). An investigation of the causal relations which may exist between the scalelike shape of the particles of clays and the characteristic properties of the clays has led to the following conclusions: The scalelike minerals consist of consecutive layers of positive and negative ions. The cleavage planes are formed by particularly polarizable ions of which all are either positive or negative. The presence of these ions produces an electric field of considerable intensity. On the other hand, the water molecules are

dipolar. Hence, as soon as they enter the electric field of a cleavage surface they arrange themselves in a lawful manner. It is believed that the cohesion, plasticity, and other characteristic properties of the clays are essentially due to the orientation of the water molecules within the electric field of the cleavage surfaces. If replacing the water by a liquid whose molecules are not bipolar (tetrachlorcarbon), the clay mixture fails to exhibit the clay properties. On the other hand, if using as a substitute for the water another liquid with dipolar molecules (*e.g.*, SO_2 or NH_3 at low temperature) the clay properties persist. The interaction between the water and the cleavage planes is greatly intensified by the fact that the scalelike particles dominate in the finest fraction of the clays. The investigators believe that the water capacity of the clays is also connected with the polarization effects. E.P.R.

Geology and Natural Resources of Colorado. RUSSEL D. GEORGE. Reviewed in *Econ. Geol.*, **23** [4], 466–67 (1928). University of Colorado Semicentennial Series 1877–1927. University of Colorado, Boulder, Colo., 1927. Pp. xv + 228, illustrated. Price $2.00. E.P.R.

Geology of Mongolia. Natural History of Central Asia. Vol. II. CHARLES P. BERKEY AND FREDERICK K. MORRIS. Pp. xxxi + 475, illustrated, price $10.00. G. P. Putnam's Sons, New York (1927–28). Reviewed in *Econ. Geol.*, **23** [4], 467 (1928). E.P.R.

Elements of Geophysics as Applied to Explorations for Minerals, Oil, and Gas. RICHARD AMBRONN. Reviewed in *Econ. Geol.*, **24** [1], 103–104 (1929). Translated by M. C. Cobb. 372 pp. with bibliography and illustrations. Theodor Steinkopf, Dresden and Leipzig (1926); McGraw-Hill Book Co., New York (1928).—The purpose of the book is not to serve as a textbook for the execution of geophysical surveys, but (1) to provide a complete and well-balanced review of all the geophysical methods that may be used in economic geology, so that the geologist, mining engineer, layman, or executive, who has to do with them or is considering the use of them, may come as completely as possible to understand their possibilities and applicabilities and (2) to provide for the practical geophysicist and others interested in applied geophysics, reference to the thought and literature on the subject. E.P.R.

Pit and Quarry Handbook for 1929. ANON. Reviewed in *Pit and Quarry*, **17** [10], 62 (1929).—The 1929 revised and enlarged edition for producers and manufacturers of cement, lime, gypsum, crushed stone, sand and gravel, and other nonmetallic minerals is ready for distribution. New sections added to the book in addition to rewriting, revision, and enlargement of other sections make the 1929 Handbook much more complete, useful, and up-to-date than the obsolete 1928 edition. R.G.E.

Chemistry and Physics

Reflecting power of beryllium, chromium, and several other metals. W. W. COBLENTZ AND R. STAIR. Bur. Stand., *Jour Research*, **2** [2], 343–54 (1929).—Data are presented on the ultra-violet reflecting power of various metals, beryllium, chromium, cobalt, nickel, silver, speculum, stellite, and stainless steel. For chromium and beryllium the observations extend into the infra-red. The observations show that contrary to the general experience with other metals, beryllium has a high reflectivity at 250mμ in the ultra-violet, followed by an appreciably lower reflectivity with a minimum at about 400 mμ in the visible spectrum. Chromium has a higher reflectivity than nickel in the ultra-violet and is, therefore, the more efficient as a reflector of ultra-violet radiation. R.A.H.

Discharge coefficients of square-edged orifices for measuring flow of air. H. S. BEAN, E. BUCKINGHAM, AND P. S. MURPHY. Bur. Stand., *Jour. Research*, **2** [3], 561–658 (1929).—Air at pressures between 1 and 13 atmospheres was passed through square-

edged concentric orifices installed in long, straight pipes of 4, 6, and 8 in. nominal diameter, the 3 pipes being in series. At each orifice the temperature and static pressure were observed, and the fall of pressure through the orifice was measured between pairs of tape located in each of the 3 ways commonly adopted in commercial orifice meter practice. The rate of flow was measured by throttling the air nearly to atmospheric pressure and discharging it through a flow nozzle on the end of the line. The design, calibration, and peculiarities of behavior of the nozzles are described, and the theory of this method of measurement is discussed in the appendix. Such nozzles appear to be very satisfactory for use as primary standards. The various quantities known as discharge coefficients and used in orifice meter computations are defined. The experimental results are represented by equations connecting the values of the discharge coefficients with the ratio of orifice to pipe diameter and with the ratio of downstream to upstream static pressure. Tables of numerical values of discharge coefficients are also given. R.A.H.

Standard samples. ANON. Bur. Stand., *Tech. News Bull.*, No. 142, p. 13 (1929).—New standard samples that have been recently prepared by the Bureau are the standard sample of fluorspar No. 79, ferrophosphorus No. 90, and opal glass. The chemical compositions of these materials are given. R.A.H.

Bibliographies. ANON. *Proc. A.S.T.M.*, **28** [1], 377–93(1928).—Bibliographies are published on modulus of elasticity, Poisson's ratio, inelastic deformation, and volume changes of concrete. R.A.H.

Calibration of extensometers. R. L. TEMPLIN. *Proc. A.S.T.M.*, **28** [2], 714–27 (1928).—A new design of a device for calibrating extensometers arranged for measuring deformation on gage lengths varying from $^1/_2$ to 10 in. inclusive is discussed. This calibration device indicates total deformations to the nearest 0.000002-in. The scheme used to obtain such refinement of measurement has as its basis the use of a differential-thread micrometer screw and a 5 to 1 lever supported on a system of plate fulcra. The special micrometer screw can be calibrated by means of a suitable jig and Johansson blocks, or a precise end-measuring machine or suitable interferometer. Errors due to temperatures, design, workmanship, and manipulation are discussed. Calibration data pertaining to the micrometer screw are included together with results obtained on a few different types of commercial extensometers. R.A.H.

Correct load application in Rockwell hardness testing machines. F. S. MAPES. *Proc. A.S.T.M.*, **28** [2], 728–36 (1928).—To determine correct load application in Rockwell hardness testing machines, several methods were tried out. The final scheme adopted involved a steel bar supported on knife edges with the load applied at the center. With a dial gage below, the load deflections of the bar could be accurately measured and by using this device in a standard vertical testing machine with loads of 10, 100, and 150 kg. applied, the bar was calibrated. The set-up was then transferred to the Rockwell hardness testing machine and check deflections secured. By applying this method to three Rockwell machines it was found that very slight percentages of error were encountered. The method being simple, accurate, and inexpensive, it is readily adaptable to commercial use. R.A.H.

Deval abrasion tests of aggregates. STANTON WALKER. *Proc. A.S.T.M.*, **28** [2], 745–67 (1928).—A number of different investigators have been studying the Deval abrasion test to develop a method suitable for application to different types of aggregates. The principal conclusions which may be drawn from the data presented are: (1) The differences in the percentages passing sieves suitable for measuring the dust of abrasion indicate the desirability of taking into account more than one sieve in measuring the wear. (2) Measurement of the differences of the fineness modulus before and after the test provides a convenient method for taking into account the amounts passing (or re-

tained on) all sieves used in making the analysis. (3) For given groups of tests the differences in fineness modulus are approximately proportional to the percentage of wear as measured by the amount passing the No. 14 sieve. (4) The wear of the aggregates increased with the number of revolutions of the cylinder. (5) Amount of wear decreased by increasing the weight of the sample. (6) Tests indicate that for large samples the abrasive action of the testing machine was more prominent, while for smaller samples the impact action of the abrasive charge and of the larger aggregate particles had an important effect on the amount of wear. (7) The effect of increasing the number of cast-iron balls in the abrasive charge was similar to increasing the number of revolutions of cylinder. (8) For tests of different gradings, the greatest amount of wear was obtained for a sample consisting of equal parts of fine and coarse with the medium size omitted. (9) Varying the proportions of fine and coarse caused great differences in the amount of wear. (10) Variations in the proportions of medium and coarse, omitting the fine size, had relatively little effect on the amount of wear. (11) The same amount of wear was obtained for a great many different gradings. (12) Variations in the amount of wear due to grading were greater in the case of the gravel than of the aggregates tested. (13) The amount of wear for angular aggregates was greatly decreased by rounding the particles before the test. R.A.H.

Methods of particle size determination. LINCOLN T. WORK. *Proc. A.S.T.M.*, **28** [2], 771–812 (1928).—The aims in fineness measurement of ground materials, pigments, fuels, and cements have been noted. (1) Fineness tests are of two types: direct measurement and indirect comparison. By actual observation, the direct methods measure the amounts of material of each size and they should be regarded as standards of reference. By the measurement of some property which varies with fineness, the indirect methods give in a single value an estimate of the degree of fineness, but they should be checked for accuracy by the direct method. These methods are usually rapid and often are a more useful measure of the property of the material than a fineness curve obtained by direct measurement. (2) Sieving is rapid and accurate to as low as 74 microns, with certain limitations as to the nature of the material, the method of sizing, and the closeness of the nest intervals. Separation is determined by the fitting of the minimum cross-section of the particle through the sieve aperture. (3) Elutriation has its greatest usefulness from 5 to 100 microns. Within that interval, separation is supposed to follow Stokes' law. (4) Microscopic sizing has been developed for the range from a few tenths of a micron to about 10 or 20 microns, but with care it may be used up to 100 microns or more. (5) Sieving, elutriation, and microscopic sizing may be combined to give fineness curves over a wider range of size and with greater ease than would be possible with one of these alone. Particle shape is an important factor in this correlation. (6) In representing fineness data, the following points should be stressed: simplicity, usefulness, fundamental value, and universal application. (7) Such indirect methods as settling rate in a fluid medium, apparent density, or packing volume, hiding or light dispersing power, rate of solution, X-ray dispersion, plasticity, and effect in products, are normally based upon a function, the exact variation of which to distribution of particle size is still uncertain. R.A.H.

Data on atomic dimensions. EDGAR T. WHERRY *Amer. Mineral*, **14** [2], 54–58 (1929).—By means of X-ray it is possible to measure with a high degree of accuracy the distances between the centers of layers of atoms in crystals, and, whenever the arrangements of atoms in these layers can be worked out, the distances between the centers of adjacent atoms can be calculated. Until recently, however, there has been a considerable difference of opinion as to what fraction of the distance is assignable to each member of the pair of atoms. In halite, for example, the distance between Na and Cl centers is known with precision to be 2.814 atomic units, but what proportion of this length may

be regarded as representing the radius of the sodium, and what the chlorine, remains to be determined. On the basis of some reasonable though admittedly empirical assumptions as to the refractive powers of atoms, Goldschmidt has calculated effective radii of a large number of atoms in variously charged conditions, and Pauling, on the basis of modern wave-mechanics theories of electron arrangement, has presented theoretical values for most of the same elements, the two series of data agreeing well in many cases. The radius values deduced in these studies, with a few from other sources, are listed. The elements are arranged in the order of their atomic numbers and data are given for three different conditions, namely positively charged, neutral, and negatively charged (the first and last being termed ions). In many instances the radii for each condition given by different methods of calculation or by measurements on different classes of compounds show some divergence, so instead of a single value a range is stated.

F.P.H.

Crystal forms of calcium sulphate. L. S. RAMSDELL AND E. P. PARTRIDGE. *Amer. Mineral.*, **14** [2], 59–73 (1929).—Three crystal forms of calcium sulphate exist, rather than four. These are gypsum, hemihydrate, and anhydrite. Soluble anhydrite is identical in crystal structure with hemihydrate, the latter apparently belonging to the zeolitic class of substances which lose and regain water of hydration without change in crystal structure. The term "hemihydrate" should, therefore, be interpreted not as referring to a compound with a definite water content, but as referring to a compound which gives a certain definite X-ray diffraction pattern. The term "soluble anhydrite" is a misnomer, and should be replaced by the term "dehydrated hemihydrate" which more nearly expresses the true relationship of the hemihydrate and the material obtained by complete dehydration at low temperatures. The transition temperature for the change from gypsum to anhydrite when in contact with water is provisionally placed at 38°C; the change from gypsum to hemihydrate, when in contact with water, is more definitely placed at 98°C. Anhydrite has been obtained experimentally from gypsum in contact with water at 100°C, with evidence of setting similar to that of plaster of Paris. Gypsum has been obtained from anhydrite in contact with water at 11 to 15°, with evidence of setting similar to that of plaster of Paris. The conversion of gypsum to anhydrite at 100°C, and of anhydrite to gypsum at 11 to 15°, are analogous to the conversion of hemihydrate to gypsum noted in the setting of plaster. In each case a more soluble unstable solid phase dissolves in water, with subsequent crystallization of a less soluble stable phase from the solution which is supersaturated with respect to it.

F.P.H.

New gas analyzing apparatus. E. OTT. *Bull. Schweiz Ver. Gas und Wasserfach.*, (1928); *Gas Age-Rec.*, **63** [4], 112 (1929).—The apparatus is incased like the Orsat. It consists of (*a*) one burette with a two-way cock (*b*) four Orsat pipettes, one for absorbing carbon dioxide in a 1:2 caustic potash solution, one for absorption of heavy hydrocarbons in fuming sulphuric acid with 25% sulphur trioxide content, one for the absorption of oxygen in phosphorus, and one for the absorption of carbon monoxide in a mixture of iodine pentoxide in fuming sulphuric acid containing 10% sulphur trioxide. The latter is provided with an additional tube, which permits, with the aid of the funnel top of the burette, the removal of the gas residue, by means of water, thus avoiding the presence of injurious excess space in the absorption. Hydrogen and methane are determined by fractional combustion with copper oxide. The tube in which the operation is carried out is shown. This part of the apparatus is filled with nitrogen gas so that there is no empty space in the combustion chamber. The combustion gases are also absorbed in the pipette. The apparatus is provided with the usual pressure equalizing devices as well as with a thermometer and an oven for heating the combustion tube containing copper oxide. The apparatus is claimed to work better and more easily than most of the devices used in the routine analysis of gas.

F.P.H.

Structure and constitution of feldspar. FELIX MACHATSCHKI. *Centralblatt. Min. Geol. A.*, pp. 97–104 (1928); *Mineral. Abs.*, **3** [10], 477–78 (1928).—W. Wahl's coördination formulas for albite $(Al_2(SiO_3)_2(SiO_3)_2)K_2$ and anorthite $(Al_2O_2(SiO_3)_2)Ca$ do not explain the isomorphism of this pair of minerals. As the fundamental unit of silicate structures M. takes a tetrahedral group of four O^{-2} ions around a Si^{+4} ion. Aluminum Al^{+3} with O^{-2} may have coördination number of 4 or 6, and when 4 it may take the place of silicon in the tetrahedral group of oxygens. Similarly, Be^{+2} and perhaps B^{+3} may also occupy this position. Since tetrahedra cannot fill space, the cavities between them may be occupied by the metal ions. In the feldspar type of silicate structure (where Si + Al:O = 1:2) every oxygen ion is common to two adjacent tetrahedra, and the formulas are written:

$$\text{Albite } \left[\begin{matrix}(SiO_2)_3 \\ AlO_2\end{matrix}\right]^{-1} \quad Na + 1$$

$$\text{Anorthite } \left[\begin{matrix}(SiO_2)_2 \\ (AlO_2)_2\end{matrix}\right]^{-2} \quad Ca + 2$$

F.P.H.

Relation between kaolin and clays. G. CALSOW. *Chem. Erde*, **2**, 415–44 (1926); *Mineral. Abs.*, **3** [10], 486 (1928).—Partial analyses are given of eight samples of kaolin, montmorillonite, and other clays from various localities. These materials were heated *in vacuo* (4 mm. pressure) and the loss of water plotted against temperature. Kaolin loses the bulk of its water between 400 and 450°C. From the amount of water lost between these limits by other clays, the percentage of crystalline kaolin contained is calculated, the remainder being assumed to be amorphous clay material. For such mixtures the name kaolinite is reserved as a rock name (analogous to amphibolite, peridotite, etc.). F.P.H.

Kaolin content of clays. HERMANN BOEGE. *Mineral. Abs.*, **3** [10], 487 (1928).—Chemical analyses are given of eight clays from German localities. Digesting the material in hydrochloric acid (d. 1:1) for two hours from 6.00 to 14.08% $Al_2O_3 + Fe_2O_3$ went into solution; this representing the colloidal portion of the aluminum silicate. After ignition of the material at 700° hydrochloric acid extracted more (up to 36.82%) alumina, the additional amount representing the broken-down kaolin. From these results the amount of kaolin in the clay can be calculated. Estimation of the amount of kaolin present in each of these clays was also made by the dehydration method of Calsow (see preceding abstract). F.P.H.

Structure of β corundum. C. GOTTFRIED. *Mineral. Abs.*, **3** [11], 526–27 (1928).—A preliminary investigation by X-ray of β corundum (Al_2O_3 96.59; Na_2O 2.56%) gave refractive index 1.68, density 3.30, and oxygen-atom-volume 17.25 cubic Å, as against 1.768 and 14.05 for α corundum, pointing to a closest-packed arrangement for the latter and an open structure for the β modification. The Laue diagram shows a hexagonal axis with six planes of symmetry. The unit cell of dimensions $a = 5.63$, $c = 22.63$ Å ($c/a = 4.02$) contains twelve molecules of Al_2O_3. F.P.H.

Structure of colloidal SnO_2. R. FORSTER. *Physik. Zeits.*, **28**, 151–52 (1927); *Mineral. Abs.*, **3** [9], 430 (1928).—The *a* and *b* colloidal modifications of tin dioxide when examined by the power method appear to be identical with each other and with the crystalline modification, cassiterite, except that the space-lattices are slightly bigger. The variation of the lattice dimensions of prepared colloidal SnO_2 is not always constant, and is greatest in the case of a gel prepared by the dialysis of $SnCl_2$ solutions. In this case $a = 4.91$ and $c = 3.47$ Å (compare cassiterite, $a = 4.67$ and $c = 3.14$ Å). Other gels give lattice dimensions intermediate in value between the above two sets.

F.P.H.

Determination of optic axial angle and crystal forms. HARVEY COLLINGRIDGE. *Mineral. Mag.*, **21** [122], 552–55 (1928).—The Becke method was to record the trace of the optic axial plane when horizontal, the position of one axis, and the extinction direction. From these data and the established constants of the microscope, the position of the second optic axis may be found, as the extinction bisects the angle between the center of the pole of the section and the two optic axes. Hence, the optic axial angle may be determined. Considerable errors arise in these determinations owing to defects in the optical system of the microscope, and also to the inability to determine the exact position when the trace of the optic axial plane is parallel to the E-W lines in the microscope. The combination of all the various observations made on different thin sections of varying orientation shows which observations are best and a complete reconstruction of the crystal. F.P.H.

Investigation of synthetic slags. OTTO GLASER. *Stahl u. Eisen*, **48** [39], 1373–74 (1928).—Methods of determining such physical properties of slags as surface tension, viscosity, and melting behavior are discussed. F.P.H.

Determination of free lime. H. RATHKE. *Tonind. Ztg.*, **52** [16], 1318–21 (1928); *Rock Prod.*, **32** [5], 78 (1929).—R. describes the glycerine ammonium acetate method of Emley (*Trans. Amer. Ceram. Soc.*, **17**, 720 (1915)), the improvement of this process by use of another titration substance, and investigations concerning the degree of error brought about by percentages of water in glycerine, in respect to the determination of the presence of calcium oxide, usually designated as "free lime" in cements and other products in which it is undesirable. In the Emley method of determination, free lime is changed into calcium glycerate by treatment with glycerine, and this titrated with alcoholic ammonium acetate with phenolphthalein as indicator. This calcium oxide is only a smaller or greater portion of the total content of this chemical, and the remainder may be present in combination with aciduous substances or in fixed solution; in both instances there is no reaction which glycerine as determined by Diepschlag and Fliegenschmidt, for the latter instance. The combined lime is usually present in the form of silicates, aluminates, and among slags in the form of phosphates; these are in part considerably dissolved by water and the line enters as $Ca(OH)_2$ into solution and is thus also determined by the Emley method when water is present, so that the error occurring depends on the quantity of water available, its period of influence upon the lime combination and the ability of the latter to dissolve in water. Hence there should be no water in the glycerine and the latter should be thinned with nonaqueous alcohol. In 1882, A. Destrem found in tests that calcium glycerate is changed by water again into calcium oxide and glycerine, so that to avoid reversion of the reaction the concentration of water should be zero or as low as possible, which, being impossible, there should be a considerable large concentration of glycerine. The process of dissolving in glycerine slows down by lumping of large quantities of calcium oxide, so that the testing material should be added in small quantities, and since the glycerine is very hydroscopic and easily absorbs moisture from the air to several per cent of its weight in a few hours, the testing apparatus should be tightly closed. There are several disadvantages in titrating with ammonium acetate, in that the solution must be titrated at a boiling heat, in that the test may take an hour for determination, and in that the boiling of the finely powdered substance in the alcohol-glycerine solution is inconvenient due to bubbling. Therefore, the titration medium, alcoholic ammonium acetate, usable only under boiling, was discarded in favor of a $1/10n$ solution of pure crystallized tartaric acid, with which the calcium glycerate can be titrated cold, and phenolphthalein again used as an indicator. Tartaric acid dissolved in alcohol does not esterify and keeps an unlimited time. Calcium tartrate and glycerine are formed from calcium glycerate and tartaric acid and no ammonia is produced in the reaction, so that none need be boiled off and, therefore, the solution can

be titrated cold. The calcium tartrate formed is insoluble in alcohol-glycerine solution and secretes a fine white precipitate without impairing the determination of the conclusion of titration by the disappearance of the red coloring caused by the phenolphthalein. The titration solution was prepared by dissolving about 7.5 g. of pure crystallized tartaric acid in one liter of absolute alcohol and one titer standardized empirically by titrating a known quantity of pure calcium oxide, the calcium oxide being obtained by drying calcium carbonate of Merck to a constant weight. The glycerine was distilled several times and the specific weight rested with the pycnometer. The calcium oxide was weighed in quantities of 0.02 to 0.1 g. into an Erlenmeyer flask, mixed with 10 to 20 cc. of glycerine, and the flask tightly closed with a rubber stopper and placed upon a moderately heated sand bath. After about 24 hrs. everything was dissolved, the solution thinned with alcohol and after addition of a few drops of a solution of 0.2 g. phenolphthalein titrated cold in 100 cc. of absolute alcohol. The average value of the titer (CaO in g. corresponding to 1 cc. solution) is 0.00472, derived from variations between 0.00471 to 0.00473 in five tests. The cheaper absolute methyl alcohol may be used in place of absolute ethyl alcohol, but its vapors are harmful to health. A burette with pinchcock is recommended in place of greased glasscocks, which stick or become leaky by use of alcoholic solutions. F.P.H.

Introduction to colloid chemistry. K. A. Goslich. *Tonind. Ztg.*, **52** [17], 1368–69 (1928); *Rock Prod.*, **32** [4], 92 (1929). F.P.H.

Production of clay and lime mixtures. Peter P. Budnikoff. *Tonind. Ztg.*, **52** [17], 1369–70 (1928); *Rock Prod.*, **32** [4], 92 (1929).—The investigations of B. of the Technological Institute, Charkow, Russia, show that by aid of clays of a certain chemical composition under certain physical conditions it is possible to produce a rather firm clay-lime-stone cementitious material without clinkering which is comparatively strong and which cannot be washed to pieces in water. The hardening of the mass could be explained by a coagulating action of the excess of bases. There are "decomposition" products in the mass of clay, humus substances, which represent lyophilous colloids; therefore, the clay batter can be considered as a system from a suspension colloid which is protected by a lyophilous colloid. If the liquefication and the consequent rehardening of the mass of clay is to be viewed as a peptization and a coagulation of the clay suspension, then its plastic condition is unconditionally dependent upon the content of protecting lyophilous colloids, which envelop the particles of clay and paste them together to a but little movable mass. In these tests, plates of 4.5 x 1.5 x 1.2 cm.-dimension were prepared from the clay and dried at room temperature; the dried-out plates were later placed in a glass containing 200 cc. of water. It was observed that with an increase in the percentage of $Ca(OH)_2$ the ability to wash the clay to pieces with water increased at first and then decreased, and that finally it could not be washed to pieces at all. First a sample of red clay was tested. When 5% $Ca(OH)_2$ of the dry clay weight was added, hardening set in, which can be explained through the coagulating influence of the base upon the colloidal substance of the clay. In another clay the resistance to being washed to pieces in water set in at 6% addition of $Ca(OH)_2$; however, this product receives only a low mechanical strength under influence of water. But if the clay samples are hardened with steam pressure similarly as sand-lime brick, a stone of various strengths, according to the kind of clay and quantity, addition of lime; the pressure and the period of steaming, may be formed. Samples of three different clays were prepared with addition of milk of lime or Portland cement or other materials giving off lime; also asbestos, phosphoric acid, sulphuric acid, which gave the clay an absolute resistance against water wash, the samples of 5 x 5 x 5-cm. size having been dried 3 days in ordinary temperatures and then hardened under 4 to 12

atmospheres (59 to 175 lbs.) pressure for 6 hrs., 10 atmospheres (147 lbs.) being the most favorable pressure, when the compressive strength was as follows:

Addition	Compressive strength	
	Kg./sq. cm.	Lb./sq. in.
6% CaO	81	1152
8% CaO	90	1280
10% CaO	180	1536
4% CaO + 4% Portland cement	82	1166
5% asbestos of loose fiber plus 8% CaO	68	967
10% Portland cement	10	142

F.P.H.

Determining free aluminum oxide in silicate mixtures and its application to kaolins and clays. L. SCHMELEW. *Trans. Ceram. Res. Inst.* (Moscow), No. 14; *Keramos*, **7** [23], T1 (1928). F.P.H.

Aluminum and iron hydroxides. J. BÖHM. *Zeit. Anorg. Chem.*, **149**, 203–206 (1925); *Mineral. Abs.*, **3** [9], 430 (1928).—X-ray power photographs of precipitated aluminum and ferric hydroxides were compared with those given by the well-crystallized minerals, diaspore, gibbsite, and goethite. Bauxite from Les Baux containing only 14.5% H_2O gave a pattern like that of "Rubinglimmer" (pyrrhosiderite), and it is concluded that bauxite is AlOOH. Aluminum hydroxide precipitated in the cold is amorphous, but from a boiling solution bauxite is formed. Gibbsite is precipitated from an alkali aluminate. Precipitated ferric hydroxide is amorphous; after slow drying it gives hematite, but when heated with KOH it yields goethite. F.P.H.

Displacement of liquids in capillaries. J. L. SHERESHEFSKY. *Nature*, **122**, 312 (1928).—If drops of two immiscible liquids are placed end to end so as to form a liquid to liquid interface, the continuous bubble of liquid so formed will begin to move in the direction of the liquid of greater surface tension. It will continue to move indefinitely depending on the length of the tube. By tilting the tube until the force of gravity just balances the force tending to produce movement of the bubble, an estimation of the force which produces the movement of the bubble can be obtained. S. works out the equation for this calculation and uses this phenomenon in measuring interfacial tensions, angles of contact, and adhesion tension of various liquids against glass. C.R.A.

Determination of dielectric strength of solid substances in uniform fields. ERWIN MARX. *Electrotech. Zeit.*, **2**, 41–44 (1929).—The measurement of the dielectric strength of solid substances in homogeneous fields is difficult because it is not possible to place the electrodes so that no disturbance of the uniform field arises. These disturbances can be avoided if the solid experimented upon is in a liquid under pressure. This eliminates edge discharges. The solid can also have a smaller area than the electrodes, making work on small test samples possible. Up to the pressures found necessary the dielectric strength of solids is not influenced by the pressure. For high frequency measurements in a liquid under pressure the measurement of the phase angle of loss of solid plates can be measured up to the point of puncture without being influenced by other causes. The method is also of very great use in the dielectric strength testing of commercial insulators. The necessary testing chambers manufactured by Siemens and Halske are described in some detail. J.T.L.

A substitute for platinum. ANON. *Eng. Min. Jour.*, **123** [10], 423 (1927).—This metal, called "Palorium," is an alloy of gold with metals of the platinum group. It is a white alloy, in appearance almost identical with platinum. It compares favorably with platinum in all of its properties and is said to offer greater resistance to corrosion by certain reagents than platinum does. A.J.M.

Flotation reagents and practice. H. S. GIESER. *Eng. Min. Jour.*, **123** [21], 842 (1927). A.J.M.

Method of estimating iron and sulphur in sulphides of iron. P. L. ROBINSON, L. A. SAYCE, AND J. STEVENSON. *Jour. Chem. Soc.*, p. 813 (1928).—It has been stated that neutral aqueous copper sulphate solution dissolves the whole of the iron from iron sulphides and an analytical procedure based upon this statement has been described. Examining this method, it is found that in the absence of free acid there is very little reaction between the sulphide and the copper sulphate solution, and that with varying concentrations of acids results both low in sulphur and discordant among themselves are obtained. A.J.M.

Determination of volatile matter in coke. F. J. EATON AND S. PEXTON. *Jour. Chem. Soc.*, pp. 1215–17 (1928).—The method involves careful heating at 950°C in an atmosphere of nitrogen for 7 min. The coke, in a platinum crucible, is weighed before and after the heating and the loss in weight represents the volatile matter. The following advantages are claimed: (1) errors due to oxidation are avoided by heating in a current of nitrogen, and it is therefore possible to obtain comparable results with cokes of different reactivities toward oxygen; (2) temperature of heating is accurately known, since the thermocouple junction is placed close to the base of the platinum crucible; (3) the method is rapid since the coke is heated in a platinum crucible which has a high heat transmission and low heat capacity and the coke rapidly attains a temperature of 950°C. A.J.M.

Influence of glass upon vapor pressure. J. RINSE. *Jour. Chem. Soc.*, pp. 1442–49 (1928).—It was found that the vapor pressure-temperature curves, in determining the dissociation of mercuric iodide by means of glass-spring indicators, were of unusual form because they were continuous instead of changing abruptly to the linear form on passing the saturation point, as required by Gay-Lussac's law. No reaction could be detected between glass and mercuric iodide and the effeot is independent of the degree of dryness. The introduction of glass powder into the vessel augments the effect. A plane glass surface does not prevent the phenomenon. Adsorption cannot explain the phenomenon, for the layers would have to be more than 500 molecules thick. A.J.M.

Study of moving flames. W. PAYMAN. *Jour. Chem. Soc.*, pp. 1738–40 (1928).—The methods used depend upon the abrupt change in the optical properties (refractive index) of a gas mixture at the surface of a flame passing through it. Two cameras are used and the results are recorded photographically. A.J.M.

Adsorption of vapor on a quartz or a glass wall. A. SMITS. *Jour. Chem. Soc.*, pp. 2952–54 (1928).—Experiments of other investigators and also of S. indicate that the adsorption of films on a mercury surface and on glass or quartz surfaces, as plane as possible, formed in almost saturated vapor, can consist of a large number of molecular layers. A.J.M.

Stability of ferrous sulphate solutions and their use in standardizing permanganate. J. A. N. FRIEND AND E. G. K. PRITCHETT. *Jour. Chem. Soc.*, pp. 3227–32 (1928). A.J.M

Importance of recovered or "secondary" tin. J. B. RICHARDSON. *Chem. News*, **138**, 107–109 (1929).—The importance of recovering tin or its compounds in all the processes in which they are used is stressed, and it is asked that statistics be kept on recovered tin. H.H.S.

Surface energy in chemical engineering. W. E. GIBBS. *Chem. and Ind.*, **48**, 127–37 (1929).—After an introduction on inter-molecular forces, states of matter, surface tension, latent heat of surface,, surface energy of solids, and adsorption, G. deals with scale prevention, electrification, molecular orientation, interface between two liquids, liquid/solid surfaces, emulsification, de-emulsification, flotation, the Trent process, lubrication, and contact catalysis. H.H.S.

Physical chemist in search of purity. ERNST COHEN. *Chem. and Ind.*, **48**, 162–69

(1929).—C. stresses the importance of having a substance physically pure, as well as chemically pure, before beginning to determine its physico-chemical contents. H.H.S.

Test for borates. A. S. DODD. *Chem. and Ind.*, **48**, 172 (1929).—The pink coloration produced by mannitol and methyl red (or Sofnol No. 1) in neutral solution is characteristic of boric acid. Tungstates give a reddish-pink similar to that of borates, but the reaction takes place more slowly. Phosphates, arsenates, and chromates interfere with the reaction by making it difficult to ascertain the exact point of neutrality. H.H.S.

Determination of small quantities of glucinum in rocks. B. E. DIXON. *Chem. and Ind.*, **48**, 172 (1929).—The difficulty of separating Gl from Ti in silicates has been overcome by the use of *p*-chloroaniline, which precipitates Ti completely and Gl not at all. H.H.S.

Faraday centenary. ARTHUR KEITH. *Chem. News*, **138**, 141–42 (1929).—On August 28, 1831, Michael Faraday at the Royal Institution, made his first successful experiments on electromagnetic induction, the discovery on which are based modern electrical science and the industries which have sprung from it. The centenary will be celebrated by numerous bodies, scientific and industrial, and many countries will be represented. H.H.S.

Orsat apparatus for complete gas analysis. ANON. *Gas u. Wasserfach*, **72**, 59–60 (1929).—A new portable Orsat apparatus for complete gas analysis and determination of nitrogen is described. T.W.G.

The system: alumina-silica and its importance in the study of ceramic materials. G. MALQUORI. *Ann. chim. applicata*, **18**, 352–61 (1928).—A review and discussion of physico-chemical research on this system. (*C.A.*)

Structural relationships in the silicates. B. GOSSNER. *Ber.*, **61B**, 1634–38 (1928).—There are groups of silicates which have a structural type common to the group. By structural type is meant a molecule containing a certain number of O atoms and a certain number of other atoms (excepting H which is too small to affect the space lattice appreciably). Silicates having a common structural type show unit cells under X-ray analysis, which have very similar dimensions and volume., although their crystallography may be entirely different. Examples of 3 groups are given: (1) babingtonite, anorthite, epididymite; (2) beryl, cordierite; (3) diopside, tremolite. (*C.A.*)

The simplest silicic acids—with observations on aluminum hydroxide. XI. Hydrates and hydrogels. RICHARD WILLSTÄTTER, HEINRICH KRAUT, AND KARL LOBINGER. *Ber.*, **61B**, 2280–93 (1928).—12.5 g. $SiCl_4$ was maintained at 60 to 65° while a stream of dry air or N_2 was passed through it and into a beaker containing 750 g. H_2O + ice which was rapidly stirred and kept at 0°. Freshly precipitated Ag_2O was introduced simultaneously to maintain the acidity at 0.01 *N*–0.04 *N* in HCl. By filtering through charcoal a clear filtrate was obtained containing 80% of the silica introduced and having a freezing point which when corrected for the HCl present corresponded to a molecular weight referred to SiO_2 of 72 to 75 indicating a monosilicic acid of 75 to 80% purity. If the acidity is greater or less, a disilicic acid (molecular weight 120 to 130) is obtained. That the latter are not mixtures of mono- and higher acids was shown by dialysis. The freezing point of these solutions rose in the course of several days until the molecular weight was over 1000 and no longer determinable. The stability of these solutions is maximum at p_H 2–3. Monosilicic acid is not precipitated by organic solvents such as MeAc. The authors assume its condensation to occur through intermolecular loss of H_2O, thus: $2\,Si(OH)_4 \longrightarrow O[Si(OH)_3]_2 + H_2O$. Those acids above the hexasilicic give precipitates with solutions of egg albumin. Silica gels prepared by the action of concentrated HCl or NH_3 + NH_4Cl showed the composition $2SiO_2 \cdot H_2O$. Potentiometric titration curves of the silicic acids show an inflection point at one

equivalent of NaOH, hydrosols and gels behaving in the same way. With the aging of a solution there is a slight displacement toward higher potentials of a portion of the curve but agreement exists from below the equivalent point onward. SiO_2, however, does not titrate like an acid. Silica gels, therefore, are not simply hydrated silica. The formulas of Biltz and Lehrer for the various forms of Al hydroxide are criticized as not being representatives of their chemical behavior. (*C.A.*)

Structural relations of rhodonite to other silicates. B. Gossner and K. Brückl. *Centr. Mineral. Geol.*, **1928A**, 316–22.—The unit cell of rhodonite has $a = 7.77$, $b = 12.45$, $c = 6.74$ A.U.; $\alpha = 85°10'$, $\beta = 94°4'$, $\gamma = 111°29'$. This is not similar to diopside, but resembles babingtonite. To express this relationship, the formula is written $Mn_3CaSi_4O_{13}\cdot MnSiO_3$, that of babingtonite being written $Ca_2Fe_2Si_4O_{12}\cdot Si_2O_4$. (*C.A.*)

Revised official British method for mechanical analysis of soils. Sub-Committee of the Agric. Education Assn. *Jour. Agric. Sci.*, **18**, 734–39 (1928).—The standard temperature for sedimentation experiments adopted is 20°. Fractions of soil are weighed in the oven-dried (100 to 105°) condition and not ignited as heretofore. The number of fractions is reduced to four, and the sampling depths and times are modified. The new scale includes (1) clay, settling 10 cm. in 18 hrs.; (2) silt, 10 cm. in 4 min. 48 sec.; (3) fine sand with maximum diameter 0.2 mm.; and (4) coarse sand with maximum diameter 2.0 mm. Fractions (3) and (4) are separated with sieves. The sieve used for the fine sand fraction is the standard No. 70 I.M.M. sieve. (*B.C.A.*)

Mechanical analysis of soils. M. Köhn. *Landw. Jahrb.*, **67**, 485–546 (1928); *Bied. Zentr.*, **57**, 385–86 (1928).—Standard methods for the mechanical analysis of soils are discussed from the point of view of their limitations and sources of error. Soil particles of diameter greater than 0.02 mm. can be satisfactorily fractionated by means of sieves; sedimentation methods are applicable only to particles of less diameter than 0.05 mm. Apparatus is described for the pipette method, in which the 10 cu. cm. pipette used for withdrawing the sample is fitted with a three-way stopcock and supported on a frame which can be raised or lowered on a ratchet attachment without undue vibration. The pipette is filled to above the mark and the excess of suspension is rinsed out through a side tube from the stopcock. The sample and rinse water is delivered through the third side tube directly to the vessel in which it can be evaporated. (*B.C.A.*)

Silicophosphoric acid. Robert Schwarz. *Z. anorg. allgem. Chem.*, **176**, 236–40 (1928).—Silica gel with a definite H_2O content is added to a slight excess of H_3PO_4 at 200°, the reaction mixture then being held at 125° until a small quantity gives a clear solution in H_2O (240–300 hrs.). The product is dried over P_2O_5 and is found to have the composition $SiO_2\cdot 2P_2O_5\cdot 4H_2O$. It is a *heteropoly acid*, its constitution being best represented by the formula, $H_8[Si(PO_4)_4]$ or $H_8[SiO_8(P_2O_5)_2]$. The complex is very weak conductivity determinations and electrolysis indicating instantaneous and complete dissociation in H_2O; the irreversibility of the reaction is due to the separation of SiO_2 in colloidal form: $H_8[Si(PO_4)_4] + 2H_2O = 4H_3PO_4 + SiO_2$. Alkalis, NH_4OH, and concentrated HCl produce the same effect. Alkali phosphates, SiO_2 and Na_2CO_3 are fused together in various proportions, a homogeneous melt with a definite crystallization temperature of 961° being obtained with the proportions $4Na_2O\cdot SiO_2\cdot 2P_2O_5$, and this is the Na salt of *silicophosphoric acid*, $Na_8[Si(PO_4)_4.]$ Attempts to prepare the analogous *silico-arsenic acid* failed. (*C.A.*)

BOOKS

A Comprehensive Treatment on Inorganic and Theoretical Chemistry. Vol. IX. J. W. Mellor. Longmans, Green & Co., Ltd., London (1929). Price 3 guineas.—As, Sb, Bi, V, Cb, and Ta are discussed. H.H.S.

Sprechsaal Calendar 1929. J. Koerner. Published by Müller and Schmidt,

Coburg.—This yearly booklet renders general data applicable to the clay, glass, and enamel industries. Contains various chemical tables, discusses briefly analyses, etching, fuels, feldspars, refractories, chemistry and physics of glass, glazes and applications, fine-ceramic bodies, minerals, fusion points, pyrochemistry, shrinkages, thermometry, etc. T.W.G.

PATENTS

Production of alkali-metal carbonates. LINN BRADLEY AND EDWARD P. MCKEEFE. U. S. 1,702,588, Feb. 19, 1929. The process of producing an alkali-metal carbonate from an alkali-metal sulphite which comprises digesting a solution of normal alkali-metal sulphite with wood, separating the resulting liquor from the cellulosic materials, evaporating the resulting liquor, and calcining the resulting dry product.

Production of caustic alkali and other products. LINN BRADLEY AND EDWARD P. MCKEEFE. U. S. 1,702,589, Feb. 19, 1929. The method of producing caustic alkali from alkali-metal sulphites, which comprises digesting a solution of the alkali-metal sulphite with a cellulose-bearing material and thereby producing a pulp and a resulting liquor, evaporating the solution to dryness and calcining and heating the resulting product to produce a furnace product containing alkali-metal carbide therefrom, and treating the furnace product with water for the production of caustic soda.

Colloidal solutions of silica for coating stone, brick, wood, or other surfaces or for impregnating fabrics. G. KING AND R. THRELFALL. Brit. 290,717, Feb. 16, 1927. Water (not in excess) is added to a solution of an alkyl silicic acid ester (or mixture of such esters) in a solvent such as alcohol which is capable of carrying water in solution or suspension. Preferably the quantity of water is such as not to decompose all of the ester. Pigments may be added preferably in admixture with solvents such as cyclohexanol which do not interfere with hydrolysis of the ester. Setting may be retarded by addition of substances such as CCl_4, turpentine, bromonaphthalene, fatty oils, shellac, synthetic resins, or essential oils and the solution may be added to pyroxylin lacquers as a stiffening or fireproofing agent. (*C.A.*)

Base-exchanging substances. A. ROSENHEIM. Brit. 302,690, Feb. 13, 1929. Base-exchanging silicates such as glauconite or artificial alkali aluminium silicates are stabilized and have their base-exchanging capacity increased by treatment at ordinary or elevated temperature and at normal or reduced pressure first with acid-reacting aqueous solutions of salts of metals which are at least divalent, and then with aqueous solutions of neutral alkali metal salts, particularly sodium chloride. Salts of iron, manganese, aluminium, chromium, nickel, copper, zirconium, zinc, tin, and titanium, and particularly ferric, aluminium, or chromic salts may be used for the first treatment, and a treatment with aqueous solutions of alkaline-reacting alkali metal salts such as sodium silicate may be interposed between the first and final treatments. Washing may be effected between the various treatments, which may be repeated in succession until hard water passed through the treated material no longer becomes turbid. Examples refer to the use, as acid-reacting salts, of ferric chloride or sulphate, zirconium nitrate, chromium chloride, titanium-potassium sulphate or fluoride, aluminium chloride, sulphate or acetate, manganese chloride, or mixtures of copper and nickel salts, iron and aluminium salts, or chromium and titanium salts, and to the use of chromium chloride followed by caustic soda. Glauconite may be subjected to preliminary treatment such as elutriation and sieving, or heating to 100 to 500° before being treated as above described.

Zinc salt solutions. METALLGES A.-G. Brit. 302,924, Feb. 13, 1929. The production of zinc salt solutions by treatment with acid of crude oxide-containing materials is so carried out that any local excess of acid with respect to the zinc oxide content of the material is avoided, whereby entry into the zinc solution of impurities is minimized.

The acid may, for instance, be added continuously or intermittently, preferably with vigorous stirring, to the crude material, which may be first made into a pulp or paste with water or zinc salt solution; or acid and crude material may be added continuously to a pasty mass of crude material and acid, the zinc oxide preferably being present in excess with respect to the acid; or a zinc salt solution obtained by mixing the material with acid may be passed through a suction filter or centrifuge continuously to separate the undissolved residues.

Aluminum chloride from clay. OSKAR JONAS, KURT WEGER, AND GOTTHARD TREBITZN. Can. 284,769, Nov. 13, 1928. Calcined clay (100 T.) is dumped into a container having a double bottom so as to form a layer several meters in height. To start the reaction a small part (about $^1/_{10}$) of the required total amount of acid corresponding to 900 tons of 26% HCl is preheated and, together with the acid washing water from a previous extraction, flowed over the clay. After the clay is entirely covered with the diluted acid, the main quantity of the above-indicated strong acid required for the extraction is gradually introduced into the container while the corresponding amount of finished extract is continuously withdrawn from below, a constant level being maintained. The supply of the HCl and the withdrawal of extract is regulated so that the temperature in the reaction zone rises to at least 105° and up to 120°. By this means the greatest part of the spent acid leaves the container after one single pass, yielding a clear finished liquor of $AlCl_3$ corresponding to about 120 to 130 g. Al_2O_3 per liter. The exhausted residue of clay is washed with water and removed from the container.

(*C.A.*)

General

Presidential address. MACDONALD C. BOOZE. *Bull. Amer. Ceram. Soc.*, **8** [3], 41–43 (1929).—An address of welcome to the various trade associations meeting in conjunction with the AMERICAN CERAMIC SOCIETY, pointing toward the need of joint action on some of the problems confronting the industry, and showing by example how concerted effort has brought results of a type very much to be desired. A plea is made for the federation of ceramic industries and industrial associations. E.J.V.

Federation of ceramic associations. J. M. MCKINLEY. *Bull. Amer. Ceram. Soc.*, **8** [3], 43–45 (1929).—A parallel is drawn between the downfall of small proprietorships before a unit system from which a full corporate development is now emerging and what may happen to ceramic associations unless they unite or federate with the AMERICAN CERAMIC SOCIETY, though each association retains its corporate and working identity. E.J.V.

Ceramic exposition and concurrent meetings. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **8** [3], 45–47 (1929).—The ideas back of the American Ceramic Exposition are enumerated, as are the ideas back of the allied ceramic association meetings. Some of the objectives of this plan that have already been achieved are mentioned, while some have been only partly achieved and others await further action. Statistics on attendance are given. E.J.V.

American Ceramic Week. ANON. *Brick Clay Rec.*, **74** [5], 324–40; [6], 404–408 (1929); *Clay-Worker*, **91** [2], 134–56 (1929); *Ceram. Ind.*, **12** [3], 313–66 (1929); *Glass Ind.*, **10** [3], 51–56 (1929).—Exhibits and papers read at the joint meeting of the AMERICAN CERAMIC SOCIETY and other ceramic associations are discussed. For other references see *Ceram. Abs.*, **8** [4], 302 (1929). E.J.V.

National Paving Brick Manufacturers Association convention. ANON. *Brick Clay Rec.*, **74** [5], 320–22 (1929); *Clay-Worker*, **91** [3], 226–28 (1929).—A report of the 23rd annual meeting held at Washington, D. C., Feb. 13–15. E.J.V.

Wisconsin clay manufacturers. ANON. *Brick Clay Rec.*, **74** [5], 342 (1929).—A report of the meeting of clay manufacturers at Madison, Wis., Feb. 12. E.J.V.

Pacific Northwest ceramic meeting. ANON. *Bull. Amer. Ceram. Soc.*, **8** [3], 52–54 (1929); *Clay-Worker*, **91** [2], 156–57 (1929).—A report of the meeting of the Pacific Northwest Section of the AMERICAN CERAMIC SOCIETY held in Seattle, Wash., Jan. 18 and 19, 1929. E.J.V.

California Clay Products Manufacturers hold annual meeting. ANON. *Clay-Worker*, **91** [2], 162 (1929).—A brief report of the meeting held at Los Angeles, Jan. 15, 1929. E.J.V.

Society of Glass Technology. ANON. *Pottery Gaz.*, **54** [621], 435–36 (1929).—A report of the January meeting at Manchester. E.J.V.

Transmission of sound through wall and floor structure. V. L. CHRISLER AND W. F. SNYDER. Bur. Stand., *Jour. Research*, **2** [3], 541–60 (1929).—This paper contains a report of the work on sound transmission through (1) a large number of masonry walls and floors and other materials which are homogeneous in construction, the results showing that weight is the most important factor under these conditions; (2) a few compound walls and floors which have a masonry core; and (3) a few stud walls. The results are given for five frequency bands covering a range from 250 to 3365 cycles per second. Transmission tests were also made for impact noises. Specifications for the construction of the various panels used are appended. R.A.H.

Clay mining for quality. H. E. NOLD. Amer. Inst. Min. and Met. Eng., *Tech. Pub.*, No. 194; *Min. and Met.*, **10** [267], 163 (1929).—An intimate knowledge of the varieties of clay and impurities in any clay deposit based on sampling and testing is necessary before selective mining can be satisfactorily done. Tests of samples must be coördinated with plant practice. Results of tests of samples should be reported to the mine officials within 48 hours after taking samples. For efficient mining officials should know more than they do about the effects of poor clay and impurities on the finished product. The management should be more familiar with mining conditions and problems. Selective mining is physically possible but increases costs according to the degree of selection required and the condition of the clay in the deposit. The degree of selection to be required is an economic problem to be solved by the management of each plant. The blending of clays for uniformity of product is essentially a plant problem and not a mine problem. F.P.H.

German Society of Glass Technology. ANON. *Keramos*, **7** [23], T9 (1928).—Abstracts are given of the various papers presented at the meeting held in Berlin, Nov. 15 to 17, 1928. F.P.H.

American Institute of Mining and Metallurgical Engineers. ANON. *Min. and Met.*, **10** [267], 116–17 (1929).—An account of the 137th meeting. F.P.H.

Institute of Metals. ANON. *Min. and Met.*, **10** [267], 145–48 (1929).—Report of the February, 1929, meeting of the Institute of Metals is given. F.P.H.

Sand-Lime Brick Assn. holds twenty-fifth convention. ANON. *Rock. Prod.*, **32** [4], 88–91 (1929). F.P.H.

High pressure steam boilers. GEORGE H. ORROK. *Mech. World*, **85** [2199], 179–80 (1929).—After alluding briefly to the history of the development of the high-pressure boiler, O. discusses the path of future development, mentioning a number of points that must be carefully considered. E.P.R.

Pittsburgh glass and pottery show. ANON. *Pottery, Glass, and Brass Salesman*, **38** [24], 9 (1929).—The 49th Annual Glass and Pottery Exhibit opened Jan. 7, in Pittsburgh. E.P.R.

Waste-heat boiler adaptable to high operating pressures. ANON. *Eng. Min. Jour.*, **123** [5], 225 (1927). A.J.M.

Purchasing lubrication. ANON. *Glass*, **5** [7], 308 (1928).—Effect of lubrication on power consumption, theory and principle of lubrication, the lubricating film illus-

trated, factors involved in purchase of lubricants, and the dependability of the manufacturer are discussed. **II.** *Ibid*, **5** [8], 361 (1928).—The other considerations are specifications, comparative value, operating conditions, viscosity, value of pour test, flash-point as indication of base, carbon residue, internal combustion engine, and duties of the plant lubricating engineer. Actual service requirements are: (1) oil should possess sufficient body to keep bearing surfaces apart at the temperature at which these bearings run; (2) it should possess such qualities as will reduce the friction to a minimum; (3) flash point should be sufficiently high to insure against the presence of too volatile constituents; (4) it should remain fluid at such low temperatures as will be met in service conditions; (5) it should have no tendency to decompose or to form such deposits as will gum up the machine and increase the friction; (6) it should contain no ingredients which will corrode, score, rust, or pit the metallic surfaces of bearings, shafting, gear teeth, or other wearing elements. A.J.M.

Steam boiler plant and general furnace efficiency. ANON. *Glass*, **6** [1], 13 (1929).—The importance of blending the coal is emphasized. A.J.M.

Factory lighting layouts. ANON. *Glass*, **6** [1], 22 (1929).—Typical lighting installations may be classified as follows: (*a*) general overhead lighting, (*b*) localized overhead lighting, and (*c*) general overhead lighting supplemented by local units. General overhead lighting consists of placing the lighting units overhead so as to provide even illumination over the whole working area of the shop. Localized overhead lighting is a modified form of general lighting. The whole of the room is illuminated, but not evenly, the units being arranged so that the regions of higher intensity are over definite working areas. General overhead lighting supplemented with local units is only required for processes where high intensities are necessary or where the light must have a definite direction. A.J.M.

British Industries Fair. ANON. *Chem. and Ind.*, **48**, S 1–42 (1929).—Held simultaneously at White City, London, and Castle Bromwich, Birmingham, Feb. 18 to Mar. 2, 1929. A trade supplement descriptive of exhibitors, particularly in chemicals and chemical plant. H.H.S.

Scientific and industrial research. ANON. *Chem. and Ind.*, **48**, 109–10(1929).—Research associations in England receiving grants-in-aid during 1928 numbered 19. The Building Research Board investigated clinker aggregates in concrete, and showed the importance of stresses introduced by shrinkage of cements and concretes during setting, hardening, and drying. The National Physical Laboratory continued its work on standards, thermometry, hydrometry, hardness testing, high temperature alloys, improved methods of analysis, and industrial X-ray problems. The Chemistry Research Board studied corrosion, the production of infusible resins, high pressure research, etc. The total expenditure on research was £634,350. H.H.S.

Industrial diseases in England. THOMAS M. LEGGE. *Chem. News*, **138**, 111 (1929).—There are 11 notifiable industrial diseases in Britain. Lead poisoning, anthrax, and skin cancer are said to be the dominant ones. Compensation is allowed for 28 industrial diseases. Miners' maladies (silicosis, etc.) are prevalent in this class. Dermatitis is on the increase. H.H.S.

Concrete industries accident prevention record. A. J. R. CURTIS. *Pit and Quarry*, **17** [9], 61–64 (1929).—Eighteen mills won the Portland Cement Assn. Safety Trophy Awards for 1928. These are the highest honors bestowed by the industry for any achievement. R.G.E.

Advantages of plant records. J. J. BERLINER. *Pit and Quarry*, **17** [10], 61–62 (1929).—To the efficiently run manufacturing business, machinery and plant records are almost vital. Advantages of records are: (1) convenient inventory of machinery and plant; (2) value of every item of machinery and plant in the books at a given date;

(3) intelligent application of the law of depreciation; (4) they show whether the rate of depreciation is sufficient; (5) facilitate making depreciating schedules and absolescence claims and insure that no properly deductible tax claim is overlooked. Forms of inventory records and machinery reconciliation statements are given. These records can be installed very easily without the usual difficulties of installing that take place when new records are being put into operation. R.G.E.

Simplification in nonmetallic minerals industry. GEORGE A. COOPER. *Pit and Quarry*, **17** [10], 77–79 (1929).—The U. S. Dept. of Commerce is engaged in waste elimination through simplification and standardization. Simplification or simplified practice, is the reduction of variety in sizes, dimensions, types, immaterial differences, etc., of commonplace commodities, and is saving American industries more than $30,000,000 annually. Some of the simplified practice recommendations that have been effected and accepted by industry are described. R.G.E.

BOOKS

Underground Practice in Mining. BERNARD BERINGER. Reviewed in *Econ. Geol.*, **24** [1], 107 (1929); for review see *Ceram. Abs.*, **8** [3], 233 (1929). E.P.R.

Industrial Organization and Management. WILLIAM B. CORNELL. Reviewed in *Abrasive Ind.*, **10** [2], 82 (1929). 650 pages.—Published by the Ronald Press Co., and furnished by *Abrasive Industry* for $5.00 and in London by the Penton Publishing Co., Ltd., for 25*s*. E.P.R.

Laws of Management Applied to Manufacturing. L. P. ALFORD. Reviewed in *Abrasive Ind.*, **10** [2], 82 (1929). 266 pages.—Published by the Ronald Press Co., and furnished by *Abrasive Industry* for $4.00 and in London by the Penton Publishing Co., Ltd., for 20*s*. E.P.R.

Bibliography of Clay and Silica Industry. ANON. Müller and Schmidt, Coburg (1928). 72 pages.—A booklet listing over 900 books covering porcelain, stoneware, glass, enamel, decoration, chemistry, testing, factories and operation, kilns and heat treatments, political economy, auditing and management, arts and history, dictionaries, directories. T.W.G.

Book Review

Assimilation and Petrogenesis: Separation of Ores from Magmas. JOHN STANSFIELD. Cloth, 196 pages, illustrated, Valley Publishing Co., Urbana, Ill. This text contains not only a résumé of the theories of petrographers regarding these controversial topics but also the results of a very considerable amount of experimental work conducted at the University of Illinois, and the School of Mines, Butte, Montana.

In Part I, the results of experiments in melting powdered igneous rocks at temperatures above 1400°C alone, and also mixed with calcite, kaolin, quartz, magnetite, hematite, siderite, dolomite, magnesite, tremolite, schists, bauxite, chromite, graphite, chalcocite, bornite, chalcopyrite, and the sulphides of iron, lead, and zinc are reported. The resultant products were examined microscopically. The great amount of labor expended in this investigation is indicated by the fact that the above series totalled 475 experiments using igneous rock varying from acidic to basic in character, including 57 experiments of fused igneous rock with kaolin, 57 with quartz, 57 with bauxite, 57 with calcite, and numerous others.

The results of the processes of assimilation are discussed with particular reference to the opinions of such distinguished investigators as Teall, Harker, Bowen, Daly.

Part II. "Separation of Ores from Magmas" is a detailed description of S.'s experiments with rock and ore minerals.

The book should be of interest to ceramists who are studying pyrochemical processes.

The book is illustrated by sixty excellent microphotographs. It is well annotated and indexed. C. W. PARMELEE

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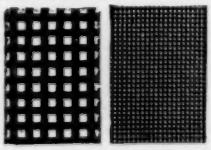

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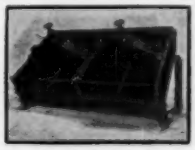

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BULLETIN

of the

AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

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EDITORIALS

COMMENT ON THE INTERNATIONAL CERAMIC EXHIBITION[1]

BY EDMUND DEF. CURTIS

For many years the American Federation of Arts has worked for recognition by the public of the value of art in life, but until this year it has been primarily interested in the Fine Arts. The General Education Board, of which Charles R. Richards is Director of the Division of Industrial Arts, has made it possible for the Federation to conduct a series of industrial art exhibitions, and the present International Ceramic Art Exhibition, comprising about four hundred pieces from Austria, Czechoslovakia, Denmark, England, France, Germany, Holland, Sweden, and the United States of America, is the first of this series.

The Exhibition opened on October 1 at the Metropolitan Museum of Art in New York and is to be shown at the Museums in Philadelphia, Minneapolis, Cleveland, Baltimore, Detroit, Newark, and Pittsburgh, staying about a month in each city. Probably between one-quarter and one-half million people will have seen it by the end of the year and a far greater number will have read of it, for it has had a great deal of publicity.

[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Chicago, Ill., February, 1929. (Art Division.) Received December 19, 1928.

The object of the exhibition is to afford an opportunity to compare American productions with those of Europe. Those who are familiar with American ceramic art cannot help a feeling of regret that the section did not include the work of Baggs, Cowan, Rookwood, Crooks, and others; as the American section stands, it is difficult to make comparison except by analysis. Probably the chief difference as a section is that the individual potters in the United States are working at considerably lower temperatures than the Europeans and as long as this continues we shall be under a self-imposed handicap. Pottery very definitely falls into certain gradations which are well based on temperature, beginning with the useful dishes and jugs of the least cultured races which are scarcely more than lightly baked, improving in quality as the heat allows a colored glaze to be used, again improving through the use of sufficient heat to allow the ware to stand constant use, jumping appreciably when the ware becomes vitrified, until the crowning quality of pure white translucent porcelain is reached.

In the graphic arts there is ample recognition of the fact that one does not compare wood cuts with water colors, printed posters with oil landscapes, but pottery is still pottery although there is a very wide gap between earthenware and porcelain, or unglazed terra cotta and stoneware. And so, although there is hardly the basis for actual piece comparison, there is another way of judging the results shown in the exhibition, and the American section shows some surprising strength.

A ceramic product must be designed, and it must be produced in clay, two distinct operations but inseparably connected. If it is to be worthy of a place in ceramic history it must have real distinction in each of the following points. It must (1) be well proportioned, (2) excel in line, (3) have appeal through color, (4) have design of decoration showing thought or meaning, (5) be right in scale, and (6) have process in keeping with the result hoped for. One cannot expect to obtain the result wanted for a painted porcelain by using a slip method. The piece must have a characteristic texture; it must have sufficient interest to lift it out of the ordinary, which may be in the form, in the color scheme, in the decoration or texture, or purely as a result of the firing. And finally the piece should give a distinct sense of the power of the creative spirit over the material and technique.

American and Foreign Ware Collectively Compared

Using this basis to compare the American section with the foreign ware 11% of the American exhibit was scored as being particularly strong in either proportion or composition as against 7% foreign; 12% of the American pieces were distinguished in line compared to 5% foreign; color showed 18% for American against 6% for foreign; in decoration Ameri-

cans scored 11 to 4% by foreign; in texture Americans were 12%, foreign 5%. Americans were 18% in interest as against 6% for foreign; in sense of power, both were 5%; 12% of American pieces showed distinction to 6% foreign.

It does not follow from this that there are more excellent pieces of American ware than in the foreign sections; it simply means that more American pieces had distinction in one or more points. We may expect fine things from future shows of this kind if the American factories will note the fine results the foreigners have obtained from efficient well equipped factories working with skilled and trained designers, if the American craftsmen will lift their eyes and hearts toward a higher standard, and if the future designers and craftsmen can be taught to think and design in ceramic processes and products.

Individual Exhibits

There were many pieces in the exhibition that were fine in one or two points, but very few that made one feel "here indeed is a pottery man." The pieces that gave the writer a feeling of profound admiration may be briefly mentioned:

No. 56. Larsen, working with Bing and Grondahl; a porcelain vase with underglaze fish decoration and crackled glaze, a remarkably fine piece from every angle.

No. 44. A small blue porcelain bowl by Bing and Grondahl; it could not have been produced by any other method, not even a huge sapphire carved and ground and polished could have rivaled the depth of color and the brilliance of this piece.

No. 153. A small bowl by Constance Wade had a tremendous lot of charm and interest, underglaze painted and crackled; a real child of the fire.

No. 213. A plate by Jean Luce decorated in black and platinum with a single fish; a triumph of style, quality, and simplicity.

Nos. 178 and 176. Two pieces by Delaherche in stoneware reaffirm the Frenchman to be a master potter.

Nos. 200 and 199. Pieces by Lenoble. Brown stoneware with contrasting relief, a fine result of a rare combination of power, skill, and knowledge.

No. 174. A gray stoneware pot by Decoeur; it would look as though it belonged there if placed in a room of the finest Sung pieces.

No. 60. Figure of Susanne, by Malinowski working with the Royal Copenhagen Manufactory; a splendid example of the foolishness of condemning overglaze work as a method.

No. 143. John Skeaping, a Royal Academy sculptor working with Wedgwood, a fine illustration of the possibilities of a man of note working in sympathy with a plant of this type, remarkably well done in black basalt.

No. 131. W. S. Murray, a stoneware bowl; he has full realization of his material. He has been criticized for following too much the Chinese tradition, but if one is working toward ultimate perfection one must follow the trail of the clay, and it leads through the Chinese development.

No. 337. Hare's fur stoneware vase by Binns in chestnut and blue; here indeed is the master craftsman.

No. 398. By Volkmar. A peacock blue stoneware jar; a fine piece of color, good form, and complete mastery of a difficult technique.

No. 377. By Robineau. Blue-green crystalline glaze, black carved top of porcelain, unusually fine.

Suggestions for Future Exhibits

With no wish to detract in any way from the great benefit that has come to the industry from this International Ceramic Exhibition it is suggested that the next one be unhampered by rules or juries. Selection of the pieces could be controlled by having a mixed committee invite the plants and individuals whose reputation entitles them to participate to send a few pieces of their best recent work.

If the exhibition were limited as to type, either tableware, decorative porcelains, or architectural work it would avoid the bewilderment of a ceramic show such as this and might help to avoid some wrong impressions such as that of some of the critics who state that America has gone far ahead of Europe in architectural tile. There is much praise to Enfield for handling a very difficult problem like the Bok tower, the special designs for Barnes, and many others, but such work should not be compared with the slim handful of tile from Europe shown in the present exhibition, and the conclusion drawn that Europe is doing nothing fine in tile. And to dismiss the Royal Copenhagen Manufactory with a wave of the hand as "uninteresting from the standpoint of design, a porcelain of the type made famous years ago" shows a curious lack of appreciation of the craft.

A brief survey of the various processes and types of work and something about the workers, included in the catalogue, would add greatly to the enjoyment of the exhibition by the public and would help the educational value appreciably.

Every craftsman in this country should see this Exhibition and resolve to equal the Europeans in quality of material and surpass them in significance of design. Every teacher of pottery should see the Exhibition and ask himself how his teaching is equipping his students to fit into the call for designers that is coming from the industry, to visualize the great results when the buying public really appreciates fine work, and to realize that he has a great deal to do with molding public taste. Every factory manager should see the Exhibition and realize that if there are men who can design a machine that will take hot "metal" and continuously produce glass bottles, so there are men who can adapt some of these interesting techniques to quantity production, men who can introduce fine designs without breaking down the factory organization; men who can find the designer, fit him into the plant just as easily as they can operate a process for ex-

tracting two dollars worth of gold from a ton of ore at a profit. More difficult things have been done than the breaking away from the domination of the decalcomania firms. All the cities should have the Exhibition to help them realize the scope and possibilities of ceramic art; they might like an entirely different set of pieces than those that appealed to the writer, for it is after all as much a matter of personal taste in viewing such an exhibition as it is in gathering it, but they would like *something* and ceramics would begin to take on new significance.

When we have an understanding public, fine designers employed by art directors for the factories, more craftsmen of the caliber of Binns, Volkmar, and Baggs leading the way to better things, then the renaissance in ceramic art may well be known to have arrived.

PENNSYLVANIA MUSEUM AND SCHOOL OF INDUSTRIAL ART
PHILADELPHIA, PA.

TO WHAT END CERAMIC ENGINEERING?[1]

By J. H. DULLES ALLEN[2]

This is a plea from a tile maker, an appeal to the SOCIETY to admit into its councils and to its various collaborations, that thing called beauty which is the soul of ceramics.

By beauty is not meant any ladida or fillíloo idea of art, but good common sense, feet on the ground, cash on hand and cash in bank beauty, that no forward looking executive can reasonably neglect nor disregard.

Now what of beauty in our own vocation? To what end ceramic engineering, unless it conspire with art to produce that which man shall prize for its beauty?

What profiteth an industry to gain the whole world of quantity production and lose its own soul of beauty?

If ceramics is to attain the position in popular esteem it so well deserves, it will not be by quantity production nor yet by efficient methods or management. Researches in structure, colloidal this and that, gases of combustion, all of these are of the utmost importance; they and similar considerations constitute the very foundation of the industry and the science of ceramics. But in the last analysis, is not design the criterion and that which makes the public put its hand into its pocket and say, "I would rather have that than the gold which is mine?"

Some think this SOCIETY should change its name to the Society of American Ceramic Engineers. If it continues the present name in justice it should adequately recognize and represent the ceramist and ceramics of

[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, February, 1929, Chicago, Ill. (Art Division).

[2] President Enfield Pottery and Tile Works, Inc.

America. Why was the great Rodin transported while gazing upon a turquoise vase studded with purple poppies, as he has so beautifully stated? Was it due to the equivalent of the coefficient of expansion of the body and the glaze? I think not. Why is a man so moved when he gazes into the eyes of his beloved? Is it because of her blood count or hemoglobin?

Talk to the public about ceramics and see what a warm response you get! They think you are a Dodo. They think ceramics means something dug up. And why are they not interested? Because this great SOCIETY of ours and most of the members of importance are devoting themselves largely to the practical and efficient methods and means of production, analysis, and what not, and neglecting the fruit and the flower, the essence of ceramics, that beauty which is its soul.

Talk to young students of architecture on ceramics and get their reaction. They have little conception of the subject. As Thoreau, perhaps they fancy it has some biblical association; you will recall Thoreau half laughingly thought jugs must grow on trees, or come into being in some other similar fashion, and he was amazed to find so quaint an object as a potter actually working in his neighborhood! So with these students: they have no conception of the span of the craft.

The making of pottery is conceded to mark the transition of the race from savagery to barbarism, a great step, although it does not sound very impressive. The degree of civilization of prehistoric peoples is based by ethnologists upon the quality of the sherds of pottery found in the ruins. Yet few realize the span of the craft, that fired clay is right out in the fore of industrial advance in fireproofing, high tension insulation (airplane and Zeppelin spark plugs), in the chemical and electrical industry and a hundred others and in architecture the form and color of tile and terra cotta in modern American buildings, the greatest accomplishment of ceramics since China built her temples and pagodas.

The *Journal* is to my thinking dry as dust. Now and then an article appears on colored glazes: so much for color. I recall once seeing an article on design, but it was largely a matter of so designing the ware that it would nest the greatest quantity in a given space. If the *Journal* can go to color plates to illustrate microscopic structure, why not the inspiration of finished products?

The control of the ceramic industry of our country is largely in the hands of business men. There are other countries where the designer has more to say in the production and the business men are wise enough and far sighted enough to recognize his genius.

Imagine a society of architects dwelling continually upon the foundations, the structural steel, researches in mortar mixes, torque and tension, and forgetting the soul of building which is or ought to be beauty.

As an illustration of opportunities missed I shall refer to the Interna-

tional Exhibition of Ceramic Art. This as you know is sponsored by the General Education Board and held under the auspices of the American Federation of Arts.

Here was an opportunity to make America ceramic minded. The foreigners surpassed us in pottery, design, color, and form. In only one field did we show to advantage—architectural decorations. True, a number of eminent American potters were represented by fine specimens, but the international was more emphatic than the national.

This SOCIETY was brought into being by a group of scientific men. As such it is only meet that it should be their SOCIETY, controlled and conducted by them. The fact remains that it is not the AMERICAN CERAMIC SOCIETY as constituted today, and as conducted today it does not represent in a comprehensive manner the ceramics of America or the ceramists of America. Most of them are members, no doubt, but the designers and those interested in form and color are in the shade, the place in the sun being reserved for those interested in the scientific or the business phase of the subject.

It is incumbent upon a representative society (a society truly representing American ceramics) to yield to the designer a place in the sun, to recognize and encourage those devoted to the very soul of ceramics.

The plumbing fixture people have done more to make America ceramic minded in regard to tile than the entire tile industry. The designers and those interested in the form and color of the craft have done more to make America ceramic minded than the AMERICAN CERAMIC SOCIETY.

The ignorance of the average man in the United States about ceramics is quite appalling, and it will remain so if the SOCIETY continues to devote itself and its *Journal* to the narrow field of scientific problems and their solution.

If a society of painters preached only pigments and their constituents, wrote and talked to the public only on matters of canvas, fugitive and durable colors, the public would not care a hang. No one denies the paramount importance of these things but they are not good selling talk and if you want to sell the great American public on ceramics you must of necessity stress its soul—form and color.

In rebuttal it may be said the *Journal* is not for public distribution but solely for the members of the SOCIETY. There is, however, no means of knowing how much influence and how far reaching may become the influence and the impression of a magazine which is the authoritative mouthpiece of such a large and important SOCIETY. Its influence is apt to be more far reaching than is generally supposed.

Let us bear in mind, therefore, that efficiency in production and scientific research, laudible as they are, result in millions of brick, tons of terra cotta, thousands of square feet of tile, train loads of crockery, and what not, and

will not make America "ceramic minded"; if they could do so, we would not be discussing this subject today for it would have been accomplished long ago.

It is incumbent upon this SOCIETY, if it is to truly or adequately represent American ceramics, to interest itself in art, to back up the men who are devoting their lives to art, to coöperate and collaborate with them, throw open the pages of the *Journal* to their pens and brushes, to an exchange of their ideas, and to an appreciation of their work.

Those who went abroad on the Ceramic Tour must have been struck with the coördination of the business or executive departments and the art departments in the foreign factories.

In our country the reverse seems to be the rule. It is not unusual for the art department to work up an attractive and elaborate design and arrangement, only to have it go to the factory where they emasculate the design by some method of efficient production, and the result is not satisfactory to the designer, the factory production department, or to the customer whose interests are not infrequently overlooked.

It is possible to hold an exhibition every year, to obtain wide press comments and publicity; but unless we can obtain team work between our design and production departments, of form and color and the technical desiderata, we shall never succeed in making America ceramic minded. America must be sensitive and yield to those few factories of our own country and the foreign factories, who have discovered this secret of coöperation between the art department and the production department.

Professor Richards of the General Education board has been an ardent advocate of design in industry. His two well-known books are commended to those interested in the subject, (1) Art in Industry, and (2) Industrial Art and the Museum. They contain many pertinent comments, criticisms, and suggestions. In the latter, Industrial Art and the Museum, he says, "The craftsman who is simply a good technician will do us little good, nor will the creative artist without technical knowledge be of great service."

The Department of Commerce demonstrated certain wastes in duplication of sizes of tile, and established certain standards. This is all very well but that does not touch the big waste in the tile industry. It is probable that the tile industry as a whole needs less, not more, standardization.

Had the Department of Commerce interested itself in the crying need for tile of better design, called attention to the flood of futile wares of mass production littering the market and the easily demonstrable and obvious fact of the need of more interesting form and color, it might have gone a long way to stop some of the most egregious waste in the tile industry.

A much traveled architect of distinction recently told me that the war-impoverished countries were today doing more beautiful and finer work than we, the richest country in the world.

We in the ceramic industry have been so taken up with the problem of how to efficiently get the greatest quantity of tile or other products into our saggers, that we have quite overlooked the very obvious fact in the present market that it were far more efficient to set one single piece of beautiful ware than a jostling and nested quantity of commonplace products.

In the year 1933 the great city of Chicago will have a World's Fair. Knowing Chicago as we do, its spirit and its traditions in these matters, we may safely prophesy that this will be the greatest Fair ever held and that its inspiration in design and in industry will leave its impress upon the entire country for a decade, as did its predecessor, the last Chicago World's Fair. Already a committee of architects has been chosen comprising some of the most eminent men of the country, selected from various cities, a mere recital of whose names is an assurance of what we may expect in the beauty of the architecture. Let us hope that our industry and our SOCIETY will find itself in a position to take advantage of the great opportunity that will be offered by this Fair.

Let us hope that a critical comparison at that Fair of the domestic and foreign examples of ceramics will not be so disastrous as in the current International Exhibition.

Let us hope that in the intervening years, and starting today we can so order our various functions that harmony and team work will replace the present lack of sympathy between the production and the design in our industry.

Let us hope and let us see to it, that those devoting their lives to form and color and design have an equal opportunity and an equal recognition in our SOCIETY and in our industry at large, as the man of science now holds.

The SOCIETY finds itself in a somewhat critical position. Those members interested in the less technical and broader aspects of ceramics, the soul of ceramic color, form, design, and beauty, are restive and dissatisfied with the narrow policy which obtains.

It is as though architects, asked to join a society of building, found engineers in control and the official organ of the society devoted chiefly to engineering problems and practically devoid of all other aspects of the great art of building.

The critical situation arises somewhat from that old evil: government without representation.

It is an age of broadening the scope of associations. Other societies are taking in and encouraging to join, those interested in collateral work, allied arts, etc., and they are definitely seeking these affiliations to strengthen their associations and render them more comprehensive in the particular field of their endeavor.

Our SOCIETY is confronted with a dilemma. It has the proverbial two horns, either to continue the present narrow policy, lose the loyal support

and allegiance of a large number of members or squarely face the issue, interest itself in and adopt a broad and comprehensive plan, truly representative, and not only hold the Art members now in, but gain a host of other members.

The membership should include every one interested in ceramics, students, instructors and teachers, museum specialists, collectors and connoiseurs, as well as all designers in this medium—an uncultivated field of tremendous possibilities.

Today we cannot ask ceramic designers to join the SOCIETY and hand them the *Journal*. They would feel they had gotten a gold brick and we would be under the suspicion of attempting to obtain money under false pretenses.

If the SOCIETY were to embrace the broader field of ceramics there is no telling what a force it would become, there is no prophesying how far reaching would be its influence and then it would honestly be the AMERICAN CERAMIC SOCIETY.

These then are the two horns of the dilemma: (1) continue narrow and supertechnical and lose the allegiance of the broader members, or (2) follow the lead of other great societies and associations and obtain the loyal support of a host of old and new members.

IMPORTANCE OF RESEARCH ON QUALITY OF PRODUCT[1]

By H. J. LUCAS[2]

Long years ago—or was it only yesterday—there was an old deacon who lived over his store. Now, it was the nightly custom of the deacon to call down to his overworked assistant who had been on the job since daybreak:

"John!"

"Yes, sir."

"Have you sanded the sugar?"

"Yes, sir."

"Have you watered the rum?"

"Yes, sir."

"Have you dampened the tobacco?"

"Yes, sir."

"Then come up to prayers."

Now, while this is simply a bit of exaggerated humor, and certainly none of us has any intention of assuming "a holier than thou" attitude toward a generation that has passed, it is unquestionably true that, with the advance

[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, February, 1929, Chicago, Ill. (General Session.)

[2] President, Northwestern Terra Cotta Company; past president, National Terra Cotta Society.

of the twentieth century, there has been a very marked improvement in business ethics as applied to quality product. Today quality of product is perhaps the most precious asset of modern industry. For this reason alone if for no other, research is, with each passing year, becoming more and more important.

Research might be defined as a new-fangled name for an old-fashioned notion; the notion that all things are linked by cause and effect. If an effect (or result) was pleasing or desired, the cause was reduced to a formula and it was marked "good." If an effect (or result) was not satisfactory, or was not the best that might be obtained, other causes were set up, or set in motion from ascertained facts and new effects were produced, and so on endlessly. We now call this Research. The method is an old one. That incident of the apple in the Garden of Eden was an excursion into the realm of pure research. And so it went through the centuries, that discussion about knowledge of good and evil, extending to good material things and material things not so good. In our time, however, the wide and intensive mechanical and technical developments have greatly complicated our search for facts about cause and effect, and we are forced to set up another group of specialists (well trained technical men) and assign them exclusively to our research laboratories.

Some of the great corporation laboratories are as well or (in some devices, perhaps) even better equipped than the National Bureau of Standards. The General Electric Company is an example, as are Westinghouse, the United States Steel, and the American Telephone and Telegraph Company, etc.

A simple, but dramatic example of how research improves the quality of product is described in a booklet published by General Motors, called "The Open Mind."

The research engineers, according to the story, constructed a machine to run a fan belt at high tension and terrific speed, hour after hour, day after day. Under this stress the best fan belt lasted only seven hours. The belt was strengthened, and the relentless machine tore it to pieces in eight hours. Strengthened again, it lived nine hours, then ten. Next the engineers adopted a quite different principal of construction, producing a belt that stood the test for more than fifty hours. Finally, working with belt manufacturers, they constructed a belt that withstood all the machine could do to it for more than 1000 hours. So here was an improvement in quality of product of 14,000 %.

The automotive industry is admittedly in the forefront in the matter of research and testing. Volumes might be written on the subject of research as related to automobile improvements.

Despite the huge volume of shoddy goods and materials still palmed off on a credulous public which all too often is concerned with show and pre-

tense rather than with sound value, every leading industry in America is investing large sums every year in research work. Not only do they maintain their own laboratories with a corps of skilled chemists, but they also frequently have on their payrolls designers, draftsmen, artists, and engineers, all of whom are also, directly or indirectly, engaged in research work. Sometimes these employees are engaged by individual companies, sometimes they are hired by a trade association of the industry, but in any event, they are becoming a more and more important factor in developing quality of product. Indeed, in this swift-moving world no great business or industry dare relax its eternal vigilance. Investigation and discovery are far more necessary today than ever before.

Research has greatly improved the quality of architectural terra cotta. Within the past fifteen years or so it has been developed into a practically new building material. For example, how vividly the rough-surfaced terra cotta of today responds to floodlighting, and what varied and brilliant colors, textures and finishes can be obtained at the present time.

This all involves far more than simply careful selection and analysis of clay, modern manufacturing methods, the painstaking efforts of engineers and chemists, good designs, and fine modeling. It calls for imagination, daring, courage; for some of the spiritual strength of old Michael Angelo; and for the bigness of conception which characterized that great leader of men in Chicago, Daniel H. Burnham.

We are exceptionally fortunate to be entering upon a new and greater era of prosperity under the constructive and inspiring leadership of the outstanding practitioner of research in the world—Herbert Hoover. The fact that a technically trained man occupies the president's chair should be a matter of real concern and uplift to the great body of technically trained men and their principals who are members of the AMERICAN CERAMIC SOCIETY.

PAPERS AND DISCUSSIONS

MANUFACTURE AND USE OF SEMIDRY-PRESSED REFRACTORY BRICK AND SHAPES[1]

By Earl Hagar and L. W. Flood

Manufacturers and users of refractory brick and shapes are benefited greatly by improvements made in recent years in machinery for semidry-pressed fire brick. Modern machinery, tunnel kilns, and better preparation of materials for semidry pressing have added to the quality of the ware and have lowered the cost of production as well. The semidry process is a comparatively recent development and some manufacturers are not yet familiar with its distinct advantages. An explanation of the special requirements for manufacture and the resulting advantages of dry pressing are the objectives of this paper.

Fire brick, like all other clay products, are made on machinery by three different methods, which are termed soft-mud, stiff-mud, and semidry-pressed processes. It is only within recent years that it has been considered practical to make other than straight-line brick or tile by the pressed method.

The soft- and stiff-mud methods use a larger percentage of water so that when force is applied to the mold or column, the clay flows and the irregular shapes and voids are easily filled. In pressed fire brick this was considered to be a difficult thing to do. Large shapes having irregular angles or varying in thickness from one end or side of the shape to the other were not considered practical to press because these were attempted with material containing too little water to allow the clay to flow under pressure and an even density of the mass was not secured. Two or three per cent more of moisture in the clay would automatically overcome the difficulty and at the same time improve the quality of the ware.

In general, the higher the percentage of moisture without any excess the better the brick. This moisture content usually runs between 7 and 10% for the best results in semidry pressing.

Plasticity not Essential

The successful manufacture of magnesite and chrome brick, which are highly nonplastic, and of a fireclay brick with a large percentage of grog and nonplastic flint clay is evidence that it is practical to manufacture refractory shapes of nonplastic materials by the semidry-pressed method. A high percentage of plasticity is not essential since the pressure at times equals 5000 pounds or more per square inch. The plasticity of the raw material, however, should be developed to the best practical degree in order to produce the best possible ware with the least pressure.

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Refractories Division.) Received November 24, 1928.

Material Preparation Important

The preparation of the materials is a very important part for semidry pressing. Although a high percentage of plasticity is not essential, the best ware is produced with the least expense, trouble, and loss when the plasticity of the raw material is fully developed. The voids in loose material cannot be avoided and the air contained in these voids must be expelled while pressing. The minute voids, however, in each individual grain of clay, however small, can be eliminated only by taking time to let the water soak into the clay particle. When this is done, considerable increase in bond is given to material which otherwise would be nonplastic. To get the best results, the material should be allowed to stand from twenty to thirty hours after the water has been added to the ground material. This will increase the water content from 1 to 3% over what would be practical for dry pressing if the clay were not soaked.

Mechanical vs. Hydraulic Pressing

An erroneous belief has been held that brick pressed hydraulically are superior to those pressed by mechanical means. It is evident that this opinion is unfounded since the possibilities of increasing the quality of products by the semidry-pressed method are governed entirely by the methods of preparation and the nature of the materials. Any material that is absolutely nonplastic, as silica sand or dead burned magnesite, having no voids in each individual particle, can be compacted up to a certain point and further pressure will not make them more compact. Any added amount of pressure would be useless. Furthermore, any plastic material will require only a certain amount of pressure to give it its maximum compactness and any more pressure will be useless. It has been proved that a substantial mechanical machine will press to the limit on either of these materials. More time while pressing will increase the bond of the plastic materials, but at the expense of decreased production.

To produce the best brick possible from flint or nonplastic materials without soaking in preparing bins, the usual method is to use a pug mill in advance of the mixer in which moisture can be added in the form of a spray or fog. If the clay is ground in a dry pan, a small stream of water may be fed into the pan without retarding the grinding capacity and will have some beneficial effect, since the mulling of the material with water tends to force some of the water into the pores of the particles.

The clay which goes through the pan should be screened to the proper fineness, depending upon the character of the ware to be produced. Screening is important. Too large a proportion of coarse granules reduces the plasticity of the mass, and renders the production of good brick more difficult. The percentage of finely-ground clay must be large enough to fill as nearly as possible the voids between the coarse particles. Other

than tempering, proper screening is believed to be most important in the manufacture of large refractory shapes by the semidry-press method. If more care and consideration of screening were used better results would be obtained, especially in the larger shapes and tile. The pressed tile 24 by 12 by 4 is equivalent to approximately twelve 9-inch straight fire brick, and it is evident that the homogeneity of the material is most important. If one edge or corner, or even the center, contains an excess of coarse material the pressure will not be equal throughout the tile. The fine clay cannot bind the coarse material, with the result that some portions will be weaker than others.

Conclusions

Some of the many advantages to be gained by making large shapes by the semidry-pressed process are:

(1) The cost of manufacture is reduced.
(2) The workmanship is always better.
(3) The cost of handling through a drier or hot floor in many cases can be entirely eliminated.
(4) The resultant ware will be more uniform and exact in size, which is very important in construction of furnaces.
(5) The refractoriness of some clays will be increased, since experiments have shown that ware made by the semidry-pressed method will stand a heat higher than the same shape made by another process.
(6) The uniform size will reduce the fire clay used in the joints. This will increase the life of the ware, partly because the clay in the joints is seldom as high grade as the clay in the brick, nor has the shrinkage been eliminated (this reduces the quality of the entire structure) and partly because of the reduced joint area which usually is the point of greater wear.
(7) Semidry-pressed fire brick is a poorer conductor of heat than any other type of fire brick. This means that a furnace will lose less heat through radiation.

It is well known that each of the three processes now used for the manufacture of fire brick, soft-mud, stiff-mud, and semidry-pressed brick processes produce brick which have special qualifications for certain purposes. This is also true with respect to large shapes. One process of manufacture is not the best for all purposes. In certain cases hand-made shapes will always be superior, but in many others the semidry-pressed method produces better ware.

Refractory manufacturers and users should investigate thoroughly the use of semidry-pressed fire brick in 9-inch series and large shapes. They reduce the cost of production and give the users better service.

CHISHOLM, BOYD AND WHITE COMPANY
57TH AND WALLACE STREETS
CHICAGO, ILL.

BRICKMAKING IN COLOMBIA, S. A.[1]

By T. W. Garve

While our thoughts are much occupied now in this country with problems such as labor saving, fuel saving, sales increase, etc., it may be interesting to see what our neighbors are doing.

There is the Republic of Colombia next to Panama with a coast line along the Pacific as well as the Atlantic ocean, a mountainous country not easily accessible but blessed with an abundance of resources. There are oil, coal, copper, gold, manganese, platinum, emeralds, phosphate, salt, iron, limestone, and clays; but mining is done on a very small scale by American and British interests. There are in existence the finest cedar and mahogany woods. The chief exports are coffee, bananas, rubber, and cattle hides, also Panama hats. Practically all manufactured articles have to be imported.

There are about 6 million people in Colombia for an area about ten times the size of New York State. Railroads and roads are almost unknown and consequently the cities and towns are isolated settlements. It is a 10 days' journey from Barranquilla, nearly at the mouth of the Magdalena river, to the capital, Bogotá, of which the greatest part is by boat. A German Company is now operating daily airplanes from Barranquilla to Bogotá, making the trip in 10 hours against the 10 days by boat and rail. To cite one illustration of the isolation of Bogotá, one ton of cement costing $12.50 at Barranquilla, will be worth $75.00 at Bogotá.

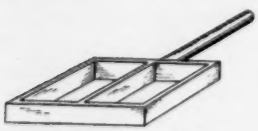

Fig. 1.—Mold.

While Colombia seems to be a fairly new country to most of us, its capital, Bogotá, was founded in 1535. The city now has about 220,000 people. It is more than 8000 feet above sea level and, though very near the equator, enjoys a pleasant climate. The lowlands along the coast are much hotter and more humid. Puerto Colombia, near the mouth of the Magdalena river, a native settlement, now is the port for ocean vessels. A narrow gage railway, belonging to an English firm, maintains communication between Puerto Colombia and Barranquilla, situated about 12 miles up the river.

At an expenditure of several million dollars, extensive river improvements are now being carried out by American and other engineers, which will enable ocean-going vessels to reach Barranquilla, thus making an important port out of a city of 125,000 people. The Magdalena river is very powerful, yet natives will go up swiftly against the current in sailboats during the time the wind blows from the ocean to the land which is from about noon till midnight.

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Heavy Clay Products Division.) Received October 20, 1928.

Brick Making

All our prospecting was done around Barranquilla. The city is still without street pavements and sewage, but has concrete sidewalks which are

FIG. 2.

extremely narrow and considerably above the road. The streets are narrow and winding as with most cities in hot countries, though a few main streets

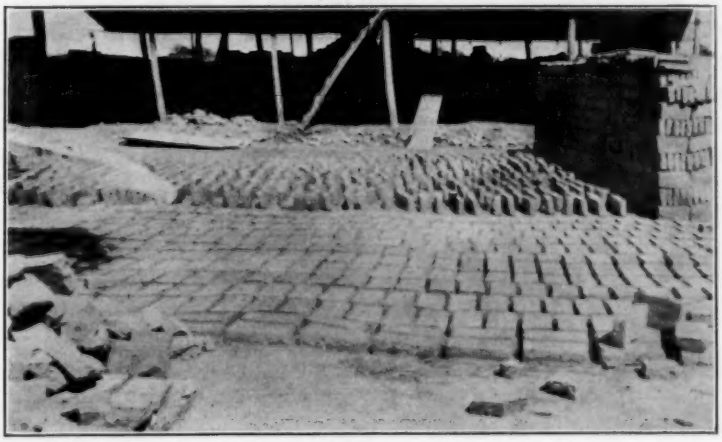

FIG. 3.

and some new avenues are straight and wide. A narrow canal, leading from the river to Barranquilla and back to the river, has a good deal of

industrial activity along its course, including some brick yards. Similar yards are found along the river banks.

If there is ever brick made by hand exclusively, it is to be found here. Some yards are using the silt from the bottom of the river near the bank or from the bottom of the canal, and other yards are using clay from the bank above and along the river. Where silt is used, the natives are

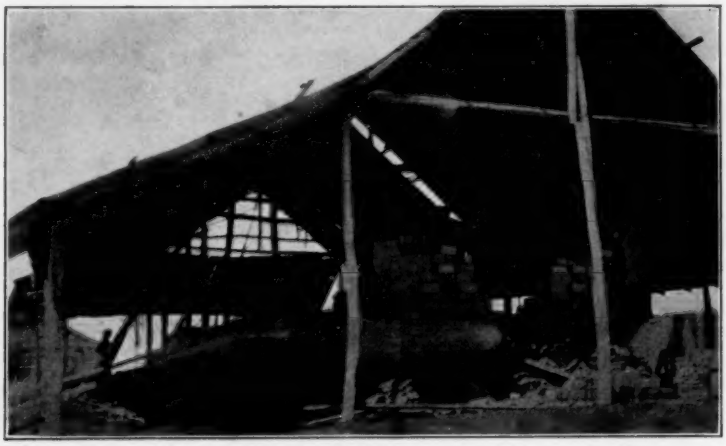

FIG. 4.

working in the water. One can see above water only the head and shoulders of the man and his scow. Then one can see him go under water and bring up with his hands a wad of clay and throw it on his scow, and he will repeat this until the load gets so heavy that the edge of the scow will be almost even with the water line. Then, wading in water, he will push his scow to the nearest brick yard. Here again, he will use nothing but his hands to unload his scow and throw the pile of clay on shore at the foot of the brick yard. This is as far as his business goes, and he will go back for more. The brick yard owner pays him $4.00 per 1000 green bricks.

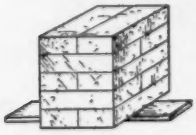

FIG. 5.—Ten brick load.

From here the clay may be either carried in or trucked into the yard, and two piles of it are made about 6 feet in diameter and about 2 feet high. Nearby will be placed a pile of wet sand. This is all that is needed. The only piece of equipment which is being used now to make the brick is an open twin mold with a handle as shown in Fig. 1. With this mold in one hand, the expert now will approach the sand pile and wield his mold around the foot of the pile until it is well coated with wet sand. He will then proceed to the pile of clay and take a wad of it into his other hand, and experience has taught him how much to take to make two bricks. If there

should be a small amount of clay left over, it goes back to the pile or to another pile. With the mold in one hand and the wad of clay in the other hand, the man walks over to the level yard where he left off, kneels down, and places his mold flat on the ground and throws his clay into it. He uses nothing but his fingers to get the clay into the corners of the mold and to have the clay fairly well leveled off over the top of the mold. This being done, he pulls his mold through the clay and obtains two more green bricks on the ground, ready to be dried by the sun. Usually two men will keep up making brick this way during the day.

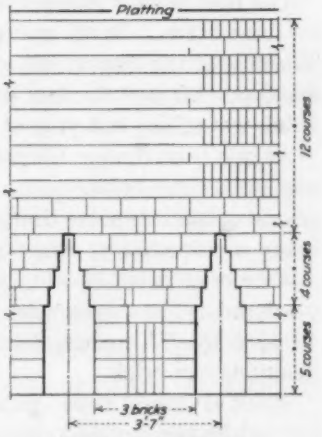

FIG. 6.—Kiln setting.

While the clay has had time to dry out in the pile to a certain extent, it is used fairly wet and much wetter than in any of our machine operations, and the linear drying shrinkage is very unreliable.

After exposure to the sun for a day, the brick are edged up by hand and trimmed by a boy, and an additional day completes the drying. In Fig. 2, one man is shown holding the mold and the freshly made brick can be seen on the ground. The sticks in the rear are wood for burning.

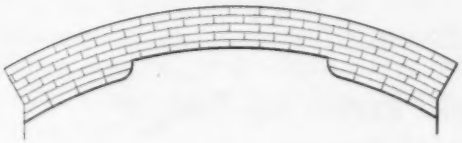
FIG. 7.

In Fig. 3 some of the brick edged up for the final drying are shown, and others piled up to obtain additional drying space. In the background the kiln is shown.

Figure 4 gives a closer view of the kiln. To the left are two planks leaning against the kiln wall serving as runways for the kiln loaders carrying the brick on the shoulder.

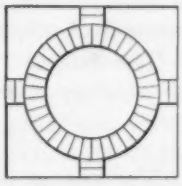
FIG. 8.

For carrying brick, green as well as fired, a narrow board is used which will accommodate 10 bricks as shown in Fig. 5 and which is carried on the shoulder. While two men are thus taking brick into the kiln, two men inside of the kiln will do the setting. The brick are set tight together and there is sufficient space left due to their unevenness to permit the air and heat to pass through the setting.

The setting is shown in Fig. 6. Wood is used for fuel, the firing is

carried out in three days, and the brick are naturally not very hard, being underfired.

The men work 8 hours a day and receive $1.50 per day and a little less on some yards. Seven men at the yard will turn out 2000 bricks per day. The cost of the clay at the yard was $4.00, the yard labor figures about $4.00 per M, and the fuel $4.00, making a total of about $12.00 per M. Brick was selling last year at about $22.00 per M.

At one time roofing tile was made near Barranquilla, as well as pottery and sand-lime brick, under European management, but these factories ceased operations some time ago. Several new clayworking plants are now being constructed by Americans here and in other parts of Colombia.

Face brick is not known now, and the common brick in the wall is heavily plastered. The handmade brick are very uneven and measure nearly 10 by 5 by $2^3/_8$ inches, being about one and one-half times as large and heavy as our brick.

Brick laying is done crudely and slowly, and one man will lay about 300 bricks per day and cover up his work with a layer of plaster one inch thick. Nevertheless, certain effects, somewhat at variance with our practice, are obtained in various ways. An arch over a wide opening is shown in Fig. 7 with five courses of brick laid endways and two bottom courses attached, all laid in cement mortar. In Fig. 8 there is some ornament frequently to be found over window or door openings outside on buildings.

Schultz Bldg.
Columbus, Ohio

SOME NEW POWER SAVING EQUIPMENT[1]

By M. W. Blair

Several new types of power-saving and cost-reducing equipment have been introduced to the heavy clay products industry during the past year. Among the most important of these are a new grinding machine, a straight line, combined pug and auger machine, and a fan for use in waste-heat driers.

The first two have received some publicity and all three have given satisfactory plant trials.

The Grinder

The grinder is a true dry pan of superior design, unusual weight, and careful construction. Some of its distinctive features are (1) weight and crushing area, (2) accessibility, (3) complete and fully enclosed lubrication, (4) Timken roller bearing throughout, (5) renewable wearing parts,

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Heavy Clay Products Division.) Received December 19, 1928.

(6) riveted structural steel screen plate support, (7) double reduction drive for standard speed motors, (8) reasonable first cost, (9) low power consumption, and (10) low operating costs (maximum output).

Thirty tons per hour, through 12-mesh, using 75 H.P., grinding hard fire clay crushed to 4 inches has been the average production on one of the installations, in a plant formerly using 4 dry pans for the same output.

Combined Pug and Auger

The term "straight line" may be applied to any machine in which the shafts carrying main gear, pugging knives, and expressing augers are in a straight line, but the machine in question is not only straight line but also has a number of unique features of construction combined with almost primitive simplicity. Some of the outstanding and original features which are largely responsible for the low power consumption are as follows:

(1) The support of auger end of shaft where it enters the barrel or nozzle back of the die.
(2) The separation into two units of the drive and auger shafts and the flexible coupling of these shafts.
(3) The provision for transmitting the thrust of the auger shaft and support of the thrust effort.

Instead of supporting the front end of the auger shaft by a bearing which in turn has to be carried by a spider or hanger inside the pugging chamber thereby obstructing the flow of clay and increasing the power consumption, the auger shaft is supported by a single turn long pitch spiral. The face of the flight is $2^1/_2$ inches wide and the diameter and pitch are large enough to pick up the loosely packed clay from the pugging knives back of it.

The spiral turns in a cage formed of wooden blocks and the inside diameter of the cage, corresponding to the outside diameter of the spiral, is 2 inches larger than the diameter of the barrel or nozzle of the machine which it feeds.

The spiral forms an ideal force feed for the augers, which is not affected by a bridging over at the end of this pug mill, and the larger diameter forms an effective stop-gap for any clay which tends to work back between the auger and barrel liners.

The blocks forming the cage work through slots in a cast frame, which is bolted to the outside of the pug mill barrel and maintains the auger in a central position, are adjustable toward the center from the outside.

As a result of the buoyancy of the clay body, the wear on the wood blocks is almost negligible.

The spiral is removed from the machine through the barrel in the same manner in which the auger mechanism is removed, only the removal of the barrel liners being necessary.

The second feature of the machine is the construction of the two-piece drive pugging and auger shaft and the unique transmission of the back thrust to the Timken roller bearing.

The two shafts are coupled at the back end of the pug chamber and in front of the main bearing. This sets the main bearing back entirely out of the mud and danger of clay reaching it from the pugging chamber is entirely eliminated.

The shaft carrying the main gear and the thrust bearing is short and heavy. In the main bearing the shaft is enlarged to nine inches in diameter and the coupling bears against this shoulder. The thrust effort is transmitted through a floating disk between the coupling halves which distributes the thrusts over a wider area to the outer circumference of the shaft but does not touch it at the center.

The auger shaft is slightly rounded on end and the coupling is sufficiently flexible to take care of much more displacement of the point auger than is ever likely to occur.

The drive shaft carrying the drive pinion and friction clutch pulley is supported by two bearings only, instead of three, and the thrust is not carried through the gear frame to back of auger shaft as in most machines. These two features make breakage of the drive shaft less likely and the second enables the driving gears to be stripped off shaft without disturbing the thrust-bearing.

Being in two units, the replacement of drive shaft and auger shaft is simplified and parts such as the cage for bearing blocks and halves of jaw coupling are interchangeable for right and left hand positions. This makes shipment of wrong hand parts for repair impossible.

The cutter drive is a part of the assembly of the machine and is built complete upon a channel turned flat side up, which runs the length of the machine; the drive being provided for in the design of the machine adds to its appearance and efficiency and does away with the afterthought appearance of most cutter drives.

The pug mill carries the battle-ax knife with renewable blade, which enables the operator to adjust the pitch easily and feed of the knives to suit the requirements of the product being manufactured and the raw material being used.

Waste-Heat Driers

A criticism of waste-heat driers has been published by the author.[2] Special attention was called to the high cost of operation and it is gratifying to be able to report what is regarded as a worth-while improvement.

[2] "Drying, Driers: Their Operation and Control," *Bull. Amer. Ceram. Soc.*, **4** [11], 596–99 (1925).

One of the principal objections has been the high cost of power, the irregular temperatures, and corrosion of car equipment. A little more than a year ago the proposed new design of a waste-heat drier was shown to several brickmakers. The outstanding and radical difference was the use of an airplane propeller, direct-connected to a high-speed motor, set in the heat duct. It was an experiment which although greatly doubted was successful.

The airplane propeller was first introduced to the ceramic industry in July, 1926. It was intended only for use in cooling fired ware. The original test nearly proved a disaster, for the intense heat was blown from the crown vents so rapidly that the plant was set on fire and, but for prompt action, would have been destroyed. It was soon found that more air, with less power consumption, was being moved than had heretofore been thought possible. Application to various industrial problems followed: incubator ventilation, boiler-room pressure for oil burners, cooling of water towers, house, office and factory ventilators, so rapidly that the capacity of the factory became overtaxed and the production of larger units was delayed until the fall of 1927 when the first application to a waste-heat drier was made at the plant of the Southern Brick and Tile Co., Louisville, Ky. If the industry profits by its use in this connection, credit should be given H. C. Kleymeyer for his coöperation in making the initial installation. The setting has since been simplified and larger units designed for subsequent installations.

The drier was originally a Barron steam drier of 10 tracks, 150 feet long between doors. The product is a soft-mud brick, with a water content of $1^3/_4$ pounds. The fan equipment is a 48-inch single propeller driven by a 3 H.P. ball bearing, direct connected, 1750 r.p.m. motor. The plant produces 32,000 brick per day, which are fired in six 30-foot round, downdraft kilns and the cooling heat from these kilns is the only heat supply. A meter on the motor for a period of 30 days showed an average power consumption of 60 kw. per 24 hours, at a cost slightly under $1.50. The plant has been in practically continuous operation for more than a year, and, except for a broken propeller, there has been no repair expense.

All of the power reduction and added efficiency in the drier operation cannot be attributed entirely to the propeller itself, although it must be admitted that it is a remarkable pull in a revolving blade some five feet long that picks up a ton or more and "takes it to Paris" in 36 hours. The absence of the frictional resistance in the ordinary housing and blades, the absence of all transmission losses, due to shafting, belts, pulleys or chain drives, is an important factor.

The design of flues, long radius curves and turns, control dampers, and care in the construction, especially in new installations, have also combined

to lessen the useless work that has heretofore been imposed upon the fan and its accessories.

Another feature has been the discouragement of the use of the underground tapping of the cooling kilns for heat, as that method short circuits the air through the lower courses in the kiln and leaves a mass of hot ware above the path of air travel. The result has been that, in many cases, artificial means have had to be employed to bring ware to a handling temperature long after the heat going to the drier was a negligible quantity and, to make up for the heat lost through this improper handling, it has often been necessary to fire boosters, use steam coils or oil burners, adding to the drying cost, and often actually lowering the quality of the product.

Due to a lack of proper testing facilities of the larger units, it is impossible to present any engineering data on performance, in volumes, pressure, etc., but actual results in lower power bills and better dried brick have been obtained in several plants.

2131 South Center Street
Terre Haute, Ind.

ACTIVITIES OF THE SOCIETY

NEW MEMBERS RECEIVED FROM MARCH 1 TO APRIL 1

Corporation

Irish Glass Bottle Co., Ltd., glass manufacturers, Charlotte Quay, Dublin, Ireland.

Missouri Clay Mining Co., clay mining and production, 1423 Ambassador Bldg., St. Louis, Mo.

United States Sanitary Mfg. Co., manufacturers of sanitary ware, Monaca, Pa.

Personal

John Bentley, Jr., The Mount, 2nd Ave., Porthill, Stoke-on-Trent, England, Tile Works Manager.

Harold F. Bopp, 616 Park St., Elgin, Ill.

James T. Burt-Gerrans, 46 Dewson St., Toronto 4, Ont., Associate Professor of Electrochemistry, University of Toronto.

B. L. Cassady, Route 2, Tulsa, Okla., Wellsville Fire Brick Co., Wellsville, Mo.

Barton W. Gaskill, Superintendent, Cellose Products Co., Toskett St., Trenton, N. J.

Howard L. Haney, Salesman and Glass Technologist, The Harshaw Chemical Co., 1610 Hanna Bldg., Cleveland, Ohio.

Joseph Tilden Irwin, 4150 E. 56th St., Cleveland, Ohio, Chemist, Ferro Enameling Co.

Harry Jerome Macke, 73 Summerhill Ave., (Clifton) Newport, Ky., Art Director, Cambridge Wheatley Co., Cincinnati, Ohio.

John Armstorf Plusch, 402 Convers Ave., Zanesville, Ohio, Ceramic Engineer, Standard Tile Co.

Louis Schmunk, Pottery Manager, Deutsche Standard Werke G.m.b.H., Neuss, Germany.

Gilbert Edward Seil, 1512 Fayette St., Conshohocken, Pa., Technical Director, E. J. Lavino & Co.

Jasper Leonidas Stuckey, State College Station, Raleigh, N. C., Professor of Geology and Mineralogy, N. C. State College.

I. E. Weinschenker, Wasily Ostrov 12, Linia, House 29, Apt. 17, Leningrad, U. S. S. R., Professor of Technology of Silicates.

H. L. Winburn, 212 W. Third St., Little Rock, Ark., Vice President, Magnolia Brick Co.

C. H. Yang, c/o C. C. Pan, College of Engineering, Chekiang University, Hangchow, Chekiang, China.

Frank P. Yeschek, 2743 Sheffield Ave., Chicago, Ill., President, Yeschek, Inc.

Students

Edmund P. Czolgos, Ohio State University, Columbus, Ohio.

Howard S. Davis, University of Washington, Seattle, Wash.

Daniel Gridley, N. Y. State School of Clayworking and Ceramics, Alfred, N. Y.

Hugo L. Harrod, Missouri School of Mines and Metallurgy, Rolla, Mo.

Edwin T. Harvey, Missouri School of Mines and Metallurgy, Rolla, Mo.

Ceryl A. Hotchkiss, Ohio State University, Columbus, Ohio.

Richard G. Humphrey, University of Illinois, Urbana, Ill.

Joseph R. Parsons, N. C. State College, Raleigh, N. C.

Neal Wyer, Ohio State University, Columbus, Ohio.

Membership Workers' Record

Corporation	
N. Stein	1
W. W. Weigel	1
Office	1
Total	3

Personal	
A. I. Andrews	1
H. B. DuBois	1
D. Hagar	1
J. E. Hansen	1
A. E. MacGee	1
R. J. Montgomery	1
C. C. Pan	1
C. Presswood	1
G. R. Shelton	1
G. Simcoe	1
W. W. Wilkins	1
Office	5
Total	16

Student	
C. M. Dodd	2
A. F. Greaves-Walker	1
C. L. Thompson	1
F. Westendick	1
H. Wilson	1
Office	3
Total	9
Grand Total	28

MEMBERSHIP WORKERS' RECORD FOR THE YEAR 1928

Corporation	
A. Coors, Jr.	1
W. H. Crume	1
J. F. Greene	1
E. L. Hettinger	1
E. N. Horr	1
D. P. Ogden	1
Office	9
Total	15

Personal	
D. F. Albery	1
A. I. Andrews	3
P. R. Babcock	1
P. H. Bates	1
F. B. Bentley	1
E. R. Berry	1
C. F. Binns	1
A. V. Bleininger	1
J. E. Brinckerhoff	1
P. P. Budnikoff	1
M. W. Butler	1
C. P. Cahoon	1
J. G. Callinan	1
J. G. Carlisle	1
A. M. Cleverley	1
S. S. Cole	1
G. W. Cooper	1
A. Coors, Jr.	1
W. F. Dalzell	1
W. F. Dietrich	1
C. M. Dodd	1
W. Emery	1
B. K. Eskesen	1
C. W. Ferguson	1
F. C. Flint	1
M. L. Fosdick	4
H. Fréchette	1
M. M. French	2
C. F. Geiger	1
S. Geijsbeek	1
R. F. Geller	1
F. G. Gibson	1
J. Gillinder	1
C. H. Griffen	1
G. Guthrie	1
V. K. Haldeman	2
J. E. Hansen	1
B. D. Hardesty	1
W. N. Harrison	1
K. Hart	3
R. A. Heindl	1
A. C. Held	1
E. L. Hettinger	1
J. Hoagland	1
F. E. Hodek, Jr.	1
C. A. Hoshour	1
J. C. Hostetter	1
G. S. Housman	1
R. D. Humphreys	1
A. H. Johnson	1
R. B. Keeler	1
W. V. Knowles	3
S. Kondo	1
N. B. Krassnikoff	1
R. Lacy	1
R. B. Landrum	4
P. W. Lee	1
C. C. Leigh	1
H. B. Lindsay	1
A. Loguin	1
S. C. Lyons	1
A. Malinovszky	2
J. M. Manor	1
O. E. Mathiasen	1
W. Mavor	2
T. P. Maynard	1
W. K. McAfee	1

PERSONAL (*continued*)	
C. B. McComas	3
D. J. McSwiney	1
R. G. Mills	1
R. J. Montgomery	1
N. Nikonoff	1
Z. I. Perkal	1
H. A. Plusch	1
L. E. Putnam	1
F. H. Riddle	1
J. A. Ryan	1
S. R. Scholes	1
W. L. Shearer	1
F. Singer	1
A. E. Stacey, Jr.	1
W. F. Steger	1
A. Stein	1
G. T. Stowe	1
R. T. Stull	2
R. E. Sturtevant	1
W. W. Tsou	1
P. H. Walker	1
E. W. Washburn	1
A. S. Watts	2
H. Weiss	1

PERSONAL	
J. B. Zeldes	1
Office	44
Total	156

STUDENT	
A. I. Andrews	4
G. H. Brown	2
P. E. Cox	8
C. M. Dodd	4
A. F. Greaves-Walker	2
A. V. Henry	2
R. K. Hursh	1
O. T. Kauffman	1
T. N. McVay	3
R. J. Montgomery	4
C. W. Parmelee	1
J. B. Shaw	5
L. R. Squier	2
J. J. Svec	3
J. D. Tetrick	1
W. H. Vaughan	7
A. S. Watts	5
F. Westendick	12
Office	2
Total	69

NEWS FROM THE LOCAL SECTIONS

Baltimore-Washington Section[1]

Following the usual dinner at 6:30 P.M. at the Village Inn, Chevy Chase, the members of the Baltimore-Washington Section met at the Bureau of Standards where the meeting was called to order by the chairman, R. A. Heindl.

Ross C. Purdy gave a short talk relative to the coming visit of the British Ceramic Society and made suggestions for their entertainment while visiting in America.

Following Mr. Purdy's talk, a program of moving pictures was shown as follows: (1) "A Modern Brickmaking Plant as represented by the Bohnsack Brick Works of Chicago." This picture was presented by Edward E. Krauss of the Chambers Bros. Co. of Philadelphia. (2) "The Application of Super-Refractories in all Types of Plants." This picture was presented by Mr. Wells and J. G. Fritzinger of the Carborundum Co.

These pictures were enthusiastically received and discussed.

The meeting adjourned to meet in Baltimore on a date in April.

OBITUARIES

Adelaide Alsop-Robineau

Adelaide Alsop-Robineau, one of the foremost women in American ceramic art, died Feburary 18, at the height of a great career. With twenty-six years of excellent porcelain production behind her, she had planned much for the future, leaving several fine pieces standing in the studio awaiting glazes at the time of her death. Among the twenty-five finished pieces remaining in Mr. Robineau's possession are some of the finest she ever did. She was also planning a London exhibition of her work.

Mrs. Robineau began her art work as a china decorator and after much study and application became a teacher at St. Mary's Hall, Faribault, Minn. Water color and

[1] E. C. Greenstreet, *Secy.*

miniature painting on ivory were also among her early efforts. As editor of *Keramic Studio*, later *Design-Keramic Studio*, Mrs. Robineau fulfilled a great ambition, to put into the hands of those actually working in art a magazine written and edited especially for them. Her husband, S. E. Robineau, is the publisher.

In 1903, Mr. Robineau secured from Taxile Doat, a well-known artist of the Manufactury of Sèvres, a series of articles for publication in *Keramic Studio* about formulas

FIG. 1.—Mrs. Robineau in her studio.

and processes used at Sèvres in the making of what is known as cone 9 porcelain fired at about 2400°F. Mrs. Robineau then saw the possibility of fulfilling another desire, that of actually designing the shape as well as the decoration. The extent to which she carried this is well known to those who have seen her work, the exquisite carvings, excised, and perforated work, as well as colorings and glazes.

The first pottery was in the basement of a rented house in Syracuse, where the chimney would not stand the excessive heat of the kiln firings. Next a plot of ground in an undeveloped part of the city was purchased and a pottery built and equipped. The house which Mrs. Robineau loved so much and occupied until her death stood nearby. During the war the ground where the pottery stood became so valuable that it was sold and the pottery moved to the residence with the kiln in a shed outside. This kiln was later given to the Syracuse University where Mrs. Robineau was a member of the faculty, and was kept in repair, free of charge, through the kindness of Richard Pass of the Onondaga Pottery and his superintendent of kilns, Mr. Parmelee. Mrs. Robineau did all the designing, throwing, and making of glazes. When all the preparation had been completed, the firing was done by her husband.

An example of Mrs. Robineau's infinite patience is shown in the story of the making of the scarab vase. After spending more than 1000 hours in carving and glazing the piece, she found that in the firing two or three large gaping cracks had formed, and the work supposedly ruined. But upon filling the cracks with ground porcelain and reglazing the vase, she again had it fired; this time it came out perfect, as illustrated in Fig. 2.

In 1910, she received Grand Prize of Ceramics at the Turin International Exposition, exhibited at the Musée des Arts Decoratifs in Paris, and at the Paris Salon in 1911. In 1915, she was given also a Grand Prize at the San Francisco Exposition. Special medals and prizes were given her by

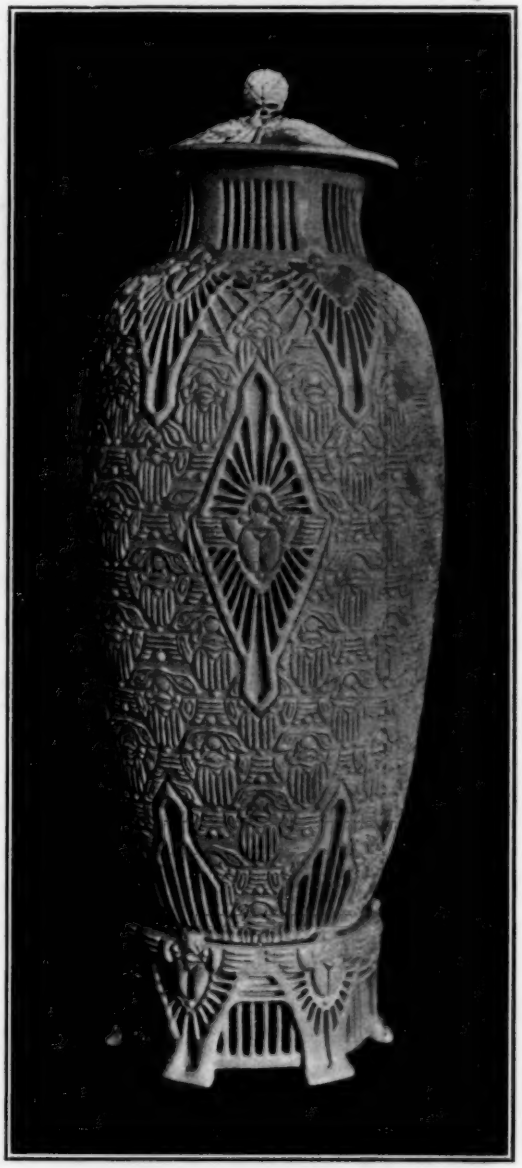

FIG. 2.—Scarab vase.

the Art Institute of Chicago, the Societies of Arts and Crafts of Detroit and Boston. In 1917, the degree of Doctor in Ceramic Sciences was conferred upon her by the Syracuse University and in 1920 she joined the faculty as instructor of pottery and ceramic design. Under her direction the students produced a low fire pottery ware which under the name of Threshold Pottery attracted attention, but porcelain was her own work.

In the April issue of *Design-Keramic Studio* Mr. Robineau spoke of his wife's burial in the following words:

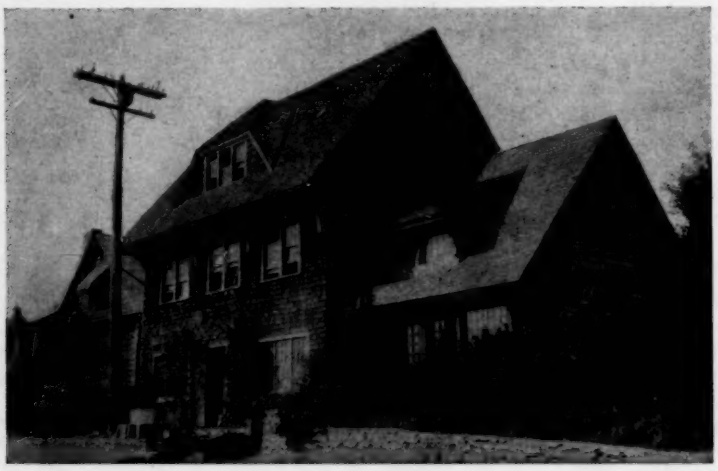

FIG. 3.—Robineau pottery on Robineau Road, Syracuse, N. Y. (1904–16).

On the 20th of February, the body of Mrs. Robineau was, at her express desire, cremated at Rochester, N. Y. A door at the end of the little chapel opened and showed a kiln room. The effect was startling; it looked so much like our familiar pottery kilns. The casket was quickly and silently placed in one of the kilns, the door of which was closed and cemented just as we had done so many, many times for the firing of her beautiful porcelains. Then the oil was lighted, also just as we always did. To those of us who were present the scene was solemn and impressive. It was her last firing.

C. M. Hollingsworth

C. M. Hollingsworth, vice-president of the Ohio Valley Clay Co., Steubenville, Ohio, was accidentally poisoned in Montreal on March 18. His death is a great loss to the company where he had served for 26 years. He had been a member of the AMERICAN CERAMIC SOCIETY since 1919.

NOTES AND NEWS

WHITEWARE DIVISION MEETING OHIO CERAMIC INDUSTRIES ASSOCIATION

The Whiteware Division of the Ohio Ceramic Industries Assn., held a very well attended meeting at Sebring, Ohio, Friday, March 29. About 75 operatives and plant men were in attendance.

The group met at the office of the Sebring Pottery Company for a tour through the plants of the French China Company and the Leigh Potters, Inc. They were very much interested in the operation of the tunnel and decorating kiln at the former plant and considerable favorable comment was heard regarding the umber ware being made at the latter. A group picture was taken at the Leigh Pottery plant.

The party assembled at the Alliance Golf Club for dinner after which T. B. Anderson, Chairman of the Whitewares Division, introduced the speakers of the evening. They were as follows: P. D. Helser, Vice-President, The Eljer Company, Ford City, Pa., R. E. Reif, Universal Sanitary Manufacturing Company, New Castle, Pa., and J. P. Thorley, Sebring Pottery Company. After the technical program was completed, President W. K. McAfee presented a few words in regard to the value of research and the Association's plans along that line for the next few years.

The two papers, presented by P. D. Helser and R. E. Reif, had to do with the preparation and control of casting slip. Mr. Helser discussed it from the angle of casting without filter presses while Mr. Reif took the opposite side of the discussion.

J. P. Thorley discussed the improvement of design and decoration with special emphasis on considering the materials to be used, the process to be employed, and the general taste to be appealed to. He also made a plea for originality in design in American dinnerware.

A list of those who attended this meeting follows:

From Coshocton, Ohio: Thos. B. Anderson and George W. Gosser, Pope-Gosser China Co.

From Newell, W. Va.: A. V. Bleininger, Clarence L. Deeds, Frederick H. Rhead, C. H. Walker, Arthur A. Wells, and Edward P. Wright, Homer Laughlin China Co.

Whiteware Section Ohio Ceramic Industries Association Meeting in Sebring and Alliance, O., March 29.

From Sebring, Ohio: W. E. Calhoun, Strong Mfg. Co.; Harry Eccleston, Curtis E. Fahnert, H. J. McMaster, Robert Watkin, J. Palin Thorley, J. E. Robinson, V. J. Roehm, C. A. Pauley, C. P. Satton, C. O. Smith, W. J. Williamson, Sebring Pottery Co.; H. W. Douda, Samuel L. Eardley, C. A. Myers, and John T. Pugh, French China Co.; James E. Fleming, Schoch Studios; Harry L. Devon, Frank Eans, James E. Eardley, P. N. Henry, and Wm. Lewis, Saxon China Co.; Ray Henry, Sebring Mfg. Corp.; Leonard G. Tait, Ceramics Dept., McKinley High School.

From East Palestine, Ohio: W. H. Locke Anderson and Joseph Hall, W. S. George Pottery Co.

From Columbus, Ohio: Arthur E. Baggs, Ceramic Art Dept., Ohio State Univ.; P. A. Bury, F. P. Hall, T. A. Klinefelter, A. Ernest MacGee, and E. P. Rexford, U. S. Bureau of Standards; R. C. Purdy, Secretary, AMERICAN CERAMIC SOCIETY, Geo. A. Bole, Secy. Ohio Ceramic Industries Assn.

From Alliance, Ohio: E. Boardman, Alliance Vitrified China Co.; J. B. Wilcox, Alliance Clay Products Co.

From New Castle, Pa.: J. V. Bowman, H. S. Kirk, and R. E. Reif, Universal Sanitary Manufacturing Co.

From East Liverpool, Ohio: Robert E. Boyce, Harker Pottery; J. D. Pearson, Consolidated Feldspar Corp.; Robert Thompson Hall, Hall China Co.; R. V. Miller, Knowles, Taylor, and Knowles; J. W. Hepplewhite, The Edwin M. Knowles China Co.; J. M. Manor, The Golding Sons Co.; B. S. Purinton, East Liverpool Potteries Co.; Dale D. Thompson, C. C. Thompson Pottery Co.

From East Sparta, Ohio: Davis A. Cable, U. S. Quarry Tile Co.; S. S. Fry, The Sparta Ceramic Co.

From Uhrichsville, Ohio: N. J. Crites, Evans Pipe Co.

From Salem, Ohio: J. M. Davidson, Frank C. Fowler, and C. G. Herbert, Salem China Co.

From Cleveland, Ohio: H. E. Fear, American Dressler Tunnel Kilns, Inc.; E. E. Pilgram, C. B. M. A.

From Ford City, Pa.: P. D. Helser and Geo. A. Wills, Eljer Co.

From Pittsburgh, Pa.: David R. Kellog and H. M. Kraner, Westinghouse Electric Mfg. Co.

From Cambridge, Ohio: W. Keith McAfee, Cambridge Sanitary Mfg. Co.

From Tiffin, Ohio: Wm. H. McKinney, Standard Sanitary Mfg. Co.; Samuel Rusoff, Sterling Grinding Wheel Co.

From Carrollton, Ohio: J. C. Montgomery and H. C. Young, Carrollton Pottery Co.

From Crooksville, Ohio: C. L. Pitcock and C. P. Stotler, Crooksville China Co.

NOTES FROM THE CERAMIC SCHOOLS

New York State School of Clayworking and Ceramics

At the bi-weekly meeting of the Student Branch of the AMERICAN CERAMIC SOCIETY of Alfred University, held February 12, J. F. McMahon of the Canadian Bureau of Mines, explained the newly formed Alumni organization of Alfred Engineers. The purpose of this organization is to further the interests of the school, coöperate with the students, and to bond together the alumni.

This organization is the out-growth of an Alfred alumni meeting held at the Annual Meeting in Chicago, which about forty Alfred alumni attended.

Among those present, who are still in school or connected with the school were Marion Fosdick, Clara K. Nelson, Miss Selkirk, Altana M. Claire, W. G. Lewis, Jr., N. H. Stolte, F. C. Westendick, N. F. Tucker, G. E. French, and C. W. Merrit.

Several papers, written by students were presented at the convention.

W. G. Lewis, Jr. and N. H. Stolte gave a résumé of the Annual Meeting of the AMERICAN CERAMIC SOCIETY at the bi-weekly meeting of Beta Pi Kappa, National Ceramic Engineering fraternity, Feb. 27.

North Carolina State College

The Department of Ceramic Engineering at North Carolina State College was awarded the "Raleigh Times" cup for the best exhibit at the Annual Engineers' Fair held recently.

The students of the department used the laboratory equipment to demonstrate the complete process of manufacturing in an art pottery and also operated the spray room and enameling furnace during the afternoon and evening in demonstrating the sheet steel enameling process.

Hundreds of visitors, including Governor O. Max Gardner and Mrs. Gardner visited the department.

A. McKinley Greaves-Walker, president of the Engineers' Council and a senior in ceramic engineering, had charge of the Engineers' celebration which covered three days.

The Student Branch of the AMERICAN CERAMIC SOCIETY at North Carolina State College brought to a close a very successful year at the annual meeting held April 10. The officers elected to serve for the 1929–30 school year were as follows: *President*, Joseph R. Parsons; *Vice-President*, Herbert T. Meyer; *Secretary-Treasurer*, William F. Brannon; *Member Engineers' Council*, Everett G. Couch, Jr.

Ohio State University

R. C. Purdy, Secretary of the AMERICAN CERAMIC SOCIETY, acted as host to the ceramic engineering students of the Ohio State University, at a dance sponsored by him at the offices of the AMERICAN CERAMIC SOCIETY, Columbus, Ohio, Thursday evening, February 21.

In addition, Mr. Purdy related the history of his interesting collection of ceramic articles on display.

A. E. Baggs, Professor, Department of Ceramic Art, gave a talk on "Pottery" before the meeting of the University Women's Club, March 4, in the Faculty Club Rooms. One of the potters wheels from the ceramic art department was set up and used for demonstration by Prof. Baggs. Several simple decorative processes were also demonstrated and many finished products were exhibited to illustrate the possibilities of the potter's craft.

W. J. McCaughey, of the mineralogy department, was the principal speaker of the evening at the dinner meeting of the Student Branch of the AMERICAN CERAMIC SOCIETY, March 5, at Pomerene Hall. His address was on "Feldspars," stressing their form of occurrence, composition, and uses.

University of Toronto

The Ceramic Club was formed Jan. 17, 1929, by junior and senior ceramic students. Dinners will be held and prominent men of the ceramic industries invited to speak.

The first dinner was given Jan. 30, when H. F. Dingledine, of the National Sewer Pipe Co. and President of the Canadian National Clay Products Assn., was the speaker. He talked on problems of graduating students and how they are to be met.

The second dinner was held March 5. Gordon Keith, Secretary of the National

Clay Products Assn., gave a detailed account of the Annual Meeting of the AMERICAN CERAMIC SOCIETY.

R. J. Montgomery, principal instructor in ceramics, was present at both meetings and talked on employment of graduates and undergraduates. W. G. Wilson is the active chairman.

The three senior students have already been offered positions in Ontario ceramic plants and the juniors have arranged for industrial experience during the coming summer.

CALENDAR OF CONVENTIONS

Organization	Date	Place
American Assn. for Advancement of Science	Dec. 27–Jan. 2, 1930	Des Moines, Iowa
AMERICAN CERAMIC SOCIETY	February, 1930	Toronto, Canada
American Chemical Society	April 29–May 3	Columbus, Ohio
American Electrochemical Society	May 27–29	Toronto, Canada
	Sept. 18–20	Pittsburgh, Pa.
American Gas Association (11th Annual Convention)	Oct. 14–18	Atlantic City, N. J.
American Institute of Chemical Engineers	June 19–21	Philadelphia, Pa.
	Dec. 2–4	Asheville, N. C.
Amer. Inst. Mining & Metallurgical Engineers	Oct. 7–9	San Francisco, Calif.
American Mining Congress (Practical Coal Operating Men and Natl. Exposition of Coal Mine Equipment)	May 13–17	Cincinnati, Ohio
American Refractories Institute	May 21	French Lick, Ind.
American Society of Mechanical Engineers	May 13–16	Rochester, N. Y.
	July 1–4	Salt Lake City, Utah
(Annual Meeting)	Dec. 2–6	New York City
American Society for Testing Materials	June 24–28	Atlantic City, N. J.
11th National Metal Exposition and National Metal Congress	Sept. 9–13	Cleveland, Ohio
Glass Container Assn. of America	May 1–3	Atlantic City, N. J.
Natl. Assn. of Manufacturers	Oct. 14–16	New York City
Natl. Assn. of Mfgrs. of Heating and Cooking Appliances	May 8–9	New York City
Natl. Glass Distributors Assn.	Dec. 3–5	Pittsburgh, Pa.
Natl. Safety Council's 18th Annual Safety Congress	Sept. 30–Oct. 4	Chicago, Ill.
Taylor Society	May 1 and 2	Charlotte, N. C.
Third International Foundrymen's Congress	June 10–13	London, England
Twelfth Exposition of Chemical Industries	Week of May 6	New York City

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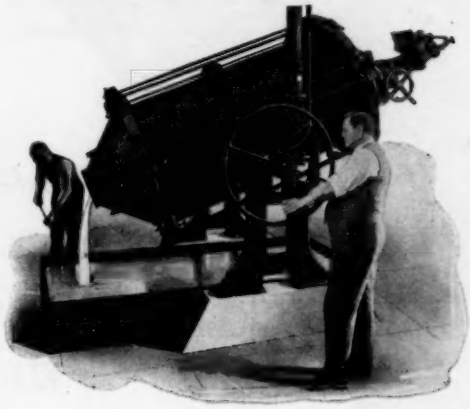

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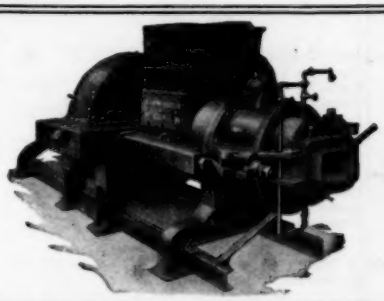

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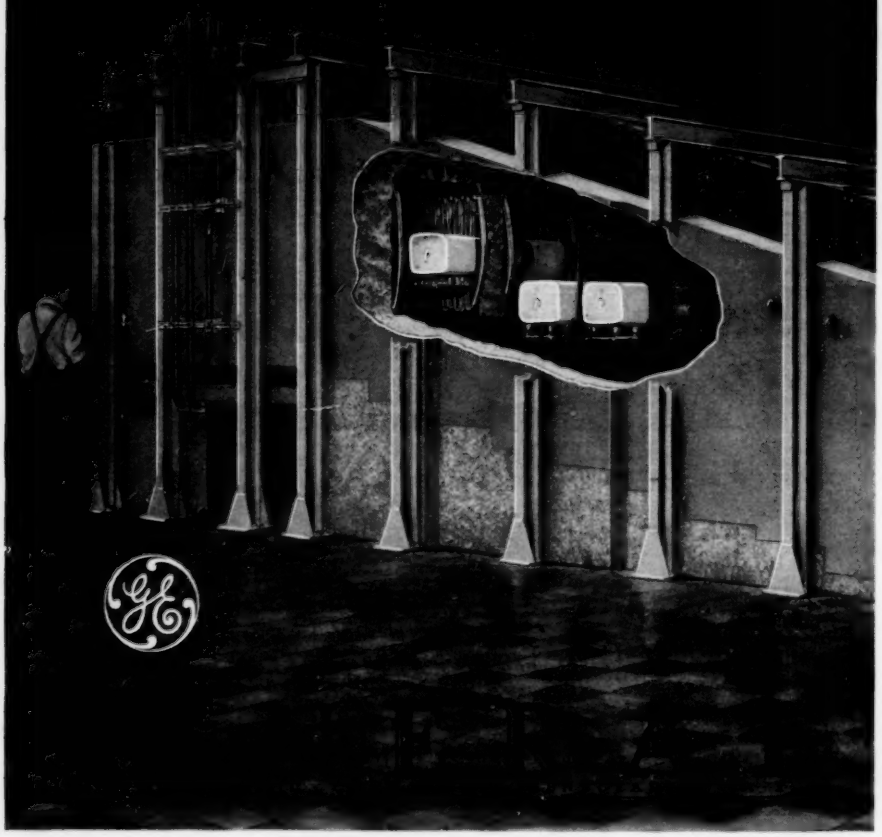

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This drawing was made from a photograph of one of the furnaces used to enamel the G-E Refrigerator evaporators. The cutaway section shows the continuous conveyor carrying the work into and out of the U-shaped firing chamber. Note that this firing chamber is considerably higher than the remainder of the furnace, thus trapping all the heat in the chamber. This virtually prevents the convection heat losses common to other types of continuous furnaces and permits the maximum interchange of stored heat between the outgoing work and the incoming work in the inclined cooling chamber.

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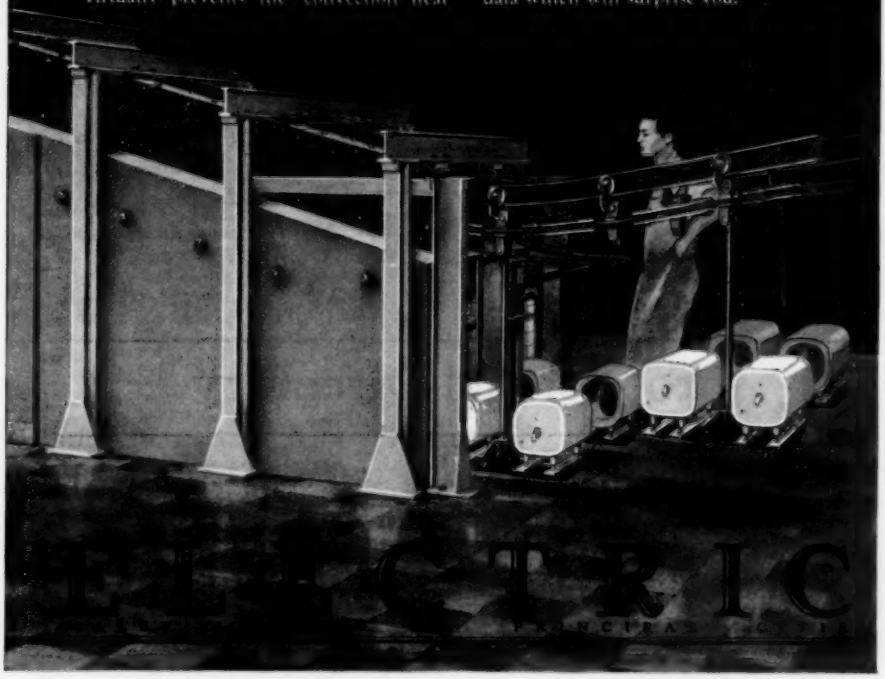

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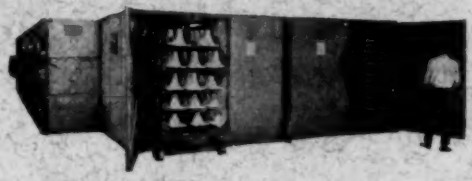

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American Rolling Mill Company, Middletown, Ohio (2).
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PREFACE

This *Bibliography* was compiled and presented by R. D. Landrum[1] and H. D. Carter.[2] The work represents many hours of searching into the literature and laborious abstracting and copying. They did this immense amount of work that they might know what information there was in the literature pertaining to vitreous enameling, thus saving themselves the time and money which would otherwise have been spent in investigations on which information is already available. The presenting of this *Bibliography* to the ceramic public without expectancy of a cash remuneration is indicative on the part of Messrs. Landrum and Carter of that same spirit of coöperation which has actuated the members of the AMERICAN CERAMIC SOCIETY during these thirty-one years.

Two hundred and thirty of the abstracts are of articles which have appeared in the *Transactions* and *Journal of the American Ceramic Society*. This is a creditable showing for the members who by writing have contributed to the arts, science, and technology of vitreous enameling.

Two hundred and fifty-five U. S. patents are abstracted, dating back to 1872. Abstracts of one hundred and fifteen British, sixty-eight German, and several patents from each of the other industrial countries are included in this *Bibliography*.

All books on enameling are listed and a complete statement regarding each is made.

There is no possibility of estimating the intrinsic value of this contribution. Time and money saving for those who are seeking information represent only a small part of the money value of this *Bibliography* to vitreous enameling industries. The greatest value realized will be from the suggestions and inspirations which the *Bibliography* will bring to those who are working and experimenting with vitreous enamels. The advent of this publication is the advent of a more substantial knowledge of and greater progress in the art, science, and technology of vitreous enameling.

The abstracts are arranged alphabetically by authors and the subject titles are given alphabetically in the index. Exhaustive cross-references are made. Every effort has been directed editorially to making this *Bibliography* most flexible and usable.—EDITOR

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[1] The Titanium Alloy Manufacturing Co., 6007 Euclid Ave., Cleveland, Ohio.

[2] The Canton Stamping and Enameling Company, Canton, Ohio.

BIBLIOGRAPHY ON VITREOUS ENAMELS WITH ABSTRACTS

***A. B. Stove Co.**

SPEED UP ENAMEL PRODUCTION WITH CONTINUOUS SPRAYER AND DRIER. See *Ceram. Ind.* (this *Bibliography*, p. 51).

Adler, H.

REMOVING ENAMEL FROM OLD AND NEW ENAMELED ARTICLES. German Pat. 374,114, Jan. 17, 1922.—Iron shot, quartz, sand, etc., are forced through steel tubes by compressed air, on to the surface of enameled articles contained in a closed chamber. (*Ceram. Abs.*, **2**, 274 (1923); *Chem. and Ind.*, **42A**, 832 (1923).)

***Aetna Porcelain Co.**

USING WASTE HEAT TO AID PRODUCTION. See *Ceram. Ind.* (this *Bibliography*, p. 60).

Agde, G., and Krause, H. F.

BEHAVIOR OF FLUORIDE INGREDIENTS OF GLASSES AND ENAMELS. I. *Z. angew. Chem.*, **40**, 525 (1927).—A series of enamels containing either sodium, calcium, or aluminium fluorides as opalizer, were melted rapidly, chilled, and reheated to produce opacity. In some cases the glass became opalescent on first cooling, in others the temperatures of reheating required ranged from 510 to 770°. In all cases the opalizing medium was a precipitated solid, either in the form of small globules, crystal skeletons, or cubes. The precipitate obtained in the sodium and aluminium fluoride series had a refractive index of 1.334 to 1.360, and was soluble in water and acids, indicating sodium fluoride (n, 1.334). In the calcium fluoride series, the value of n (1.40 to 1.44), insolubility in water, and slow solubility in acids proved the opalizing medium to be calcium fluoride (n, 1.435). All deposits were optically isotropic. With little supercooling there was a formation of small globules, but greater cooling gave either crystal aggregates or cubes depending on the concentration of the fluoride. The presence of alumina in the glass tended to reduce the size of the particles. Best results were obtained commercially with glasses which were clear on first chilling and which were subsequently so reheated as to give fine crystals. Large crystals, besides giving a weak and uneven opalescence, adversely affected the physical properties of the glass, such as elasticity. (*Chem. Abs.*, **21**, 2966 (1927); *Chem. and Ind.*, **46B**, 483 (1927); *Ceram. Abs.*, **6**, 374 (1927).)

Agde, G., and Krause, H. F.

EFFECT OF FLUORIDE ADDITIONS TO GLASSES AND ENAMELS. III. *Z. angew. Chem.*, **40**, 886 (1927).—A microscopic and Röntgen-ray study of fluorine containing silicates showed that the opacity is caused by the separation of a crystal material in the ground mass, and not by the separation of gas bubbles. With additions of sodium fluoride and aluminum fluoride, opacity is caused by the crystallization of sodium fluoride; with calcium fluoride additions, calcium fluoride and sodium fluoride separate jointly, the ratio depending on the composition and the thermal treatment of the silicates. The loss of fluorine occurs through the volatilization of the added fluorides, especially sodium fluoride and aluminum fluoride rather than through the formation and volatilization of silicon tetrafluoride. (*Chem. Abs.*, **21**, 3434 (1927); *Chem. and Ind.*, **46B**, 702 (1927).)

Agde, G., Krause, H. F., and Lehmann, W. M.

BEHAVIOR OF FLUORIDES IN GLASSES AND ENAMELS. II. *Z. angew. Chem.*, **40**, 804 (1927).—Seven members of a series of fluoride-opal glasses, previously microscopically examined were subjected to X-ray analysis. In cases in which sodium fluoride had been used as opalizer, the precipitate was found to be sodium fluoride, while a glass opalized by calcium fluoride contained a precipitate of calcium and sodium fluorides in varying proportions. The results confirmed the microscopical tests. (*Chem. and Ind.*, **46B**, 654 (1927).)

Akt.-Ges. der Emailliewerke und Metallwaarenfabriken "Austria"

PRODUCING A METALLIC LUSTER ON ENAMELED METALLIC SURFACES. French Pat. 388,761, April 1, 1908.—The enameled surface is covered with a thin layer of an essential oil or fat containing not more than 1% of a precious metal in suspension, or a similar quantity of a salt of a precious metal in solution. The oil is allowed to dry and the whole then fired at a temperature approaching the melting point of the enamel. (*Chem. and Ind.*, **27**, 982 (1908).)

Akt.-Ges. Porzellanfabr.

ENAMELING VESSELS. French Pat. 451,332, Dec. 4, 1912. (Weiden Gebr. Bauscher.).—Method of enameling vessels over the entire surface. (*Chem. Abs.*, **7**, 3210 (1913).)

***Alaska Refrigerator Co.**

ROUTING WARE THROUGH THE ENAMELING PLANT WITH LEAST COMPLICATIONS. See *Ceram. Ind.* (this *Bibliography*, p. 61).

Alber, J. M. F.

AN IMPROVED ENAMEL. British Pat. 7500, April 12, 1893.—The enamel is designed for insulators, which can be made of sheet iron coated with the patented material. The following prescription is adopted in about the proportions specified:

	Parts by weight
Calcined silica	8–10
Borate of soda	5–7
Clay	1.2–5
Arsenate of soda	0.1–3
Precipitated phosphate of lime	0.1–3
Nitrate of soda	0.2–3

(*Chem. and Ind.*, **12**, 769 (1893).)

Allen, E. T., and Zies, E. G.

METHODS OF GLASS ANALYSIS (WITH SPECIAL REFERENCE TO BORIC ACID AND THE TWO OXIDES OF ARSENIC). *Jour. Amer. Ceram. Soc.*, **1**, 739 (1918).—*I. Arsenic:* (1) An accurate method for the separation and determination of both trivalent and pentavalent arsenic in glasses is described. The separation depends on the volatilization of the trivalent arsenic as AsF_3 when the glass is heated with hydrofluoric and sulphuric acids, while the pentavalent arsenic remains in the residue. (2) These methods for arsenic in glasses are generally applicable to substances in which the arsenic can be transformed into sulphide without loss, and are highly accurate. (3) A comparison of the iodometric method and the magnesium pyro-arsenate method for arsenic in glasses is made. The former has the advantage in accuracy, and also in speed except where occasional determinations are called for. *II. Boric Acid:* (1) For the determination of boric acid Chapin's method is reliable and yields highly accurate results. (2) The

accuracy of the method is affected by arsenious but not by arsenic acid. Boric acid can be determined by oxidizing the solution with H_2O_2 after making it alkaline with sodium hydroxide. (3) Relatively large amounts of fluorides affect the accuracy of the determination but do not seriously impair its usefulness for ordinary work. Experience with the following cases in glass analysis is detailed as follows: (*a*) determination of minute quantities of iron in optical glass, (*b*) separation and determination of zinc, (*c*) separation and determination of lead and barium occurring together, (*d*) separation of calcium or barium from relatively large quantities of aluminium occurring with almost no iron, and (*e*) determination of those elements in boric acid glasses with which the boric acid interferes. (*Chem. Abs.*, **13**, 1001 (1919).)

Allen, W. D.

ENAMELING APPARATUS. U. S. Pat. 1,549,283, Aug. 11, 1925.—An enameling apparatus comprising a drying chamber including side walls and end walls, the end walls being provided with transverse openings, a substantially horizontal rack-guiding runway composed of spaced-apart track members extending continuously between the openings and formed to guide the end portions of enameling racks bridging the space between the track members, the arrangement being such that an operator at one end of the chamber may deposit racks successively upon the tracks at one end of the runway, and push the racks in a procession through the chamber for removal at the opposite end, and spaced-apart tracks arranged to support a drip pan below the runway in position to receive enamel dropping from the racks last deposited, and to permit the insertion and removal of the pan through an end-wall opening.

Alling, Harold L.

POTASH-SODA FELDSPARS. *Jour. Geol.*, **34**, 591 (1926).—The potash-soda feldspars appear to be composed of at least two end members, each of which may be trimorphous. The Millard-Michel Levy theory of submicroscopic twinning is capable of explaining cleavage angles of 90° and extinction angles of microcline and orthoclase. This theory does not disprove polymorphism. Evidently these two theories are independent of each other. The Millard-Michel Levy theory is not capable of explaining the thermal inversions noted by Des Cloigeaux and by Merwin, the cusps in the thermal expansion curves of Kozu and Saiki, or A.'s findings in the specific gravity and indices of refraction curves. The theory of polymorphism explains these phenomena. Inversion from one modification to another is so sluggish as to require a long time. A. believes that a failure to find a marked difference between Laue diagrams of orthoclase and microcline does not disprove polymorphism. Vogt has accepted Hadding's Laue diagrams as disproof of polymorphism. Winchell gives curves of γ and β potash-soda feldspars. His curves are based on the necessary assumption that the γ and β potash-soda feldspars are single-phase systems and not solutions and mixtures of two modifications. Classification of the potash-soda feldspars still awaits proper treatment. Winchell's further subdivision of the plagioclase feldspars is most complete and in strong contrast with the meager classification of the potash soda. (*Ceram. Abs.*, **6**, 114 (1927).)

***Allis-Chalmers Co.**

CLEANS CASTINGS HYDRAULICALLY. See Barringer, E. C. (this *Bibliography*, p. 14).

Allison, C. A.

MANUFACTURE OF ENAMELED VESSELS. British Pat. 23,280, Nov. 18, 1901; (London: from The Dubuque Enameling Co., Iowa, U. S. A.).—This process of manufacturing vessels, especially army canteens, consists in assembling certain parts, and

coating all the parts with enamel which is allowed to dry and is fired on, then adding the remaining parts, and again applying coats of enamel internally and externally, allowing them to dry, and finally heating to cause the coats to fuse and fill all cracks and crevices. (*Chem. and Ind.*, **21**, 477 (1902).)

***Altorfer Bros.**

WASHERS ADOPT "ENAMEL FOR PERMANENCE." See *Ceram. Ind.* (this *Bibliography*, p. 61).

A TRIP THROUGH THE A. B. C. PLANT. See *Enamelist* (this *Bibliography*, p. 110).

Amer. Machinist, **43**, 598.

ENAMELING OVENS.—Description of furnaces in operation at the Stenotype Co., Indianapolis, Ind. (*Chem. Abs.*, **9**, 2974 (1915).)

***American Radiator Co.**

THREE FURNACES ENAMEL 24,000 POUNDS CAST IRON AND 14,000 SQ. FT. SHEET IRON DAILY. See *Ceram. Ind.* (this *Bibliography*, p. 54).

LABORATORY TESTS. See *Enamelist* (this *Bibliography*, p. 109).

***American Radiator Enameling Co.**

MORE ON AMERICAN RADIATOR. See *Enamelist* (this *Bibliography*, p. 107).

***American Rolling Mill Co.**

MAKING OF VITREOUS ENAMELING SHEETS. See *Enamelist* (this *Bibliography*, p. 106).

***American Stamping and Enameling Co.**

HOW ENAMELED KITCHENWARE IS MADE. See *Iron Trade Rev.* (this *Bibliography*, p. 160).

Anderson, Olaf

VOLATILIZATION OF LEAD OXIDE FROM LEAD-SILICATE MELTS. *Jour. Amer. Ceram. Soc.*, **2**, 784 (1919).—Experiments were carried on at temperatures from 900 to 1400°. Volatilization from unstirred glass in 15 minutes took place at practically the same rate as from stirred glass heated for a longer period. Rate of volatilization falls off considerably during long heating if the glass is not stirred, for a surface film lower in PbO is formed. Volatilization at temperatures used in optical glassmaking would seem to be small enough not to cause appreciable variations in n if the procedure is reasonably constant from melt to melt but large enough to cause considerable variation in n if the melting schedule is changed.

Angelucci, Otto Rino

TESTING ENAMELED OBJECTS. *Giorn. chim. ind. applicata*, **6**, 167.—Fill the enameled vessel to be tested with a solution of an electrolyte or even with water. Connect the ends of the secondary of an induction coil so that one end is in contact with the metallic part of the vessel and the other end with the liquid contained in it. When the primary circuit is closed sparks form between the end of the secondary immersed in the liquid and that part of the metal not covered with enamel, even if such surface is a fraction of a mm. If there is no metal exposed the secondary circuit is interrupted and the current does not pass. (*Ceram. Abs.*, **4**, 4 (1925); *Chem. Abs.*, **18**, 3461 (1924).)

Appiani, G.

ENAMEL, CONTAINING NO TIN (FOR CERAMIC WARE). British Pat. 10,039, May 31, 1900.—The composition of the enamel is as follows, subject to the proportions of each

ingredient being adjusted to suit the quality of the clay: calcined sand, 19 parts; litharge, 18; kaolin, 28; common salt, 4; soda or other alkali, 3; quartz or calcined marble, 28. The claim embraces all enamels for ceramic ware that may be made without the use of tin. (*Chem. and Ind.*, **19**, 826 (1900).)

***Arimoto, Kazuo**

ACID-RESISTING ENAMELS. See Uchida Tokiji (this *Bibliography*, p. 314).

***Armstrong, C. C.**

CONTINUOUS CONVEYER ELECTRIC ENAMELING SERVICE. See *Ceramist* (this *Bibliography*, p. 62).

Armstrong, C. H.

PRODUCING ENAMELS IN THE LABORATORY. *Enamelist*, **3** [9], 26 (1926).—Description of a small laboratory pebble mill.

Armstrong, C. G.

PORCELAIN ENAMELING FURNACES. *Chem. Met. Eng.*, **24**, 486 (1921).—The art of enameling originated in Egypt about 1300 B.C. Enameling of cast iron for industrial purposes was begun in 1850 and of sheet steel in 1860. The first American plant was built at Woodhaven, N. Y., in 1863. At present both full-muffle and semimuffle furnaces are used, the latter type being more economical of heat but not suitable for coal firing on account of deposition of ash on ware. Elaborate flue systems in the upper walls and roofs of furnaces are seldom useful in extracting heat from waste flue gases and often are a means of extracting heat from the furnaces and causing the flue gases to leave the furnace at a higher temperature than if they were taken out by means of shorter flues. The logical procedure is to use a recuperator or to use a thin muffle of high conductivity. Carborundum refractories have comparatively great strength at high temperatures and a conductivity about seven times that of fire clay. The use of a thin silicon carbide muffle permits operation with a temperature difference of only 200°F between flue gases and interior of muffle, as against 800° with fire clay. This gives a fuel saving of about 30% and muffle and flue repairs are greatly reduced. (*Jour. Amer. Ceram. Soc.* (Abs.) **4**, 696 (1921); *Chem. Abs.*, **15**, 1791 (1921).)

***Armstrong Mfg. Co.**

CONTINUOUS CONVEYER ELECTRIC ENAMELING SERVICE. See *Ceramist* (this *Bibliography*, p. 62).

Armstrong, P. A. E.

STAINLESS OR RUSTLESS IRON DESCRIBED AS STABLE-SURFACE IRON. *Trans. Am. Soc. Steel Treating*, **8**, 163 (1925).—Rustless iron is not entirely resistant to surface corrosion. The film-forming characteristic that protects these alloys from serious corrosion is also the cause of discoloration. They are only stainless when conditions are favorable; such conditions are destructive to ordinary iron and often to nonferrous metals. Rustless iron must be produced free from included dirt, otherwise pitting will readily take place. A pickled surface on rustless iron is quite as good as a polished surface and less costly. Bronzes do not always cause rustless iron to corrode in the presence of an electrolyte, and care should be exercised to obtain a suitable bronze metal for bearing applications. Auto-electrolysis plays an important part. Cooking utensils are not free from danger. Rustless iron seems to be without harmful effect. Physical properties of rustless iron will bear careful scrutiny; they can be improved by the use of alloys. (*Ceram. Abs.*, **5**, 14 (1926).)

Arndt, K.

APPARATUS TO DETERMINE VISCOSITY OF FUSED SALTS. *Z. Chem. App.*, **3**, 500, 521, 549.

Arnold, H. C.

MANUFACTURE OF SINGLE-COAT GRAY ENAMELED WARE. *Jour. Amer. Ceram. Soc.*, **5**, 858 (1922).—I. The manufacture of single coat, mottled gray enameled ware presents the following problems: (1) The black shape has to be completely covered in one coat as the lack of a second or cover coat makes it impossible to hide a blemish, scratch, or mark. (2) This coat must have all the gloss, luster, and appearance of a finish coat. (3) It must show two colors, and these colors must be produced from the same enamel and in a single dipping. (4) The two colors must be present in correct amounts and, at the same time, must be distributed in such a way as to give a pleasing effect. II. Good results were obtained with the following formulas:

Feldspar	33.50	48.0	38.0	Quartz	15.00	..	12.0
Sodium carbonate	12.50	3.0	4.5	Antimony oxide	1.50	2.0	2.0
Sodium nitrate	3.75	3.0	4.5	Cryolite	3.25	3.5	4.0
Borax	24.50	29.0	28.0	Bone ash	3.75	3.0	..
Fluorspar	6.75	4.0	5.0				

III. The mottling is controlled by the following conditions: (*a*) purity of the iron; (*b*) distribution and size of particles of the impurities in the iron (structure); (*c*) degree of alkalinity or hydroxyl-ion concentration of the enamel; (*d*) degree of oxidation of the iron salts formed in the reaction. Salts used for mottling are cobalt sulphate, nickel sulphate, and ferrous sulphate. IV. The time required for developing the mottle is from two to two and one-half hours. V. The conditions for proper reaction are (*a*) regulate temperature and humidity conditions so that the piece is almost dry when the mottling is completed and it is a matter of only a few minutes for it to become completely dry, or (*b*) keep the temperature of the mottling normal and pass the completely mottled piece through a rapid drier. (*Chem. Abs.*, **17**, 456 (1923).)

Arnold, H. C.

POLARIZING MICROSCOPE AID IN FELDSPAR STANDARDIZATION. *Jour. Amer. Ceram. Soc.*, **6**, 409 (1923).—The microscope may be used in work on the following problems: (1) accessory minerals in feldspar, (2) determination of free silica or quartz, (3) study of grain shapes and sizes as they are produced from different methods of grinding, (4) nature of black specks in ground feldspar, and (5) constancy of quality in shipments. (*Chem. Abs.*, **17**, 1313 (1923).)

ZIRCONIA ENAMELS. See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 41).

Arrott, J. W., Jr.

ENAMELING TABLE. U. S. Pat. 558,339, April 14, 1896.—In a revoluble and tilting table, the combination with supporting-framings, of a swinging beam having bearings in the framings, the axes of which are above the axis of the beam, and a revolving table supported on the beam, and means for revolving the table and tilting the beam.

Ashley, H. E.

COLLOID MATTER IN CLAY. *Trans. Amer. Ceram. Soc.*, **11**, 530 (1909).—Clays are defined as mixtures of minerals of which the representative members are silicates of Al, Fe, the alkalis, and the alkaline earths. The hydrated aluminum silicate, kaolin ($Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$), is the most characteristic of these. Some feldspar is usually present. The grains of these minerals may show crystal faces, but more commonly they are of

irregular shapes and enveloped in a colloid coating. This is mainly of silicate constitution, but may consist partly of organic colloids, of Fe, Mn, and Al hydroxides, and of hydrated silicic acid. Almost any mineral may be present in clays. The combination of granular materials and colloids is in such proportion that when reduced sufficiently to fine size (by crushing, sifting, washing, or other means) and properly moistened with an appropriate amount of water, plasticity is developed. If the colloid matter is in excess, the clay is considered very plastic, fat, or sticky; but if the granular mass is in excess it is called sandy, weak, or nonplastic. The colloid matters have the property of adsorbing bases from solution. When, in each case, the final solution has reached a certain concentration, the amount of adsorbed base reaches a limiting or maximum amount. Below this maximum in most cases, the adsorption process may be represented by the usual equation, $x/m = \beta c\ 1/P$, where x = the weight of adsorbed substance, m = weight of adsorbent, c = concentration of solution, and β and P are constants. The adsorption of malachite green oxalate permits an estimate of the relative amounts of colloid matter in different clays. One clay (Tenn. No. 3 ball) is taken as a standard, assuming a colloid content of 100. If three times as much of another clay adsorbs the same amount of dye, its relative colloid content is 33; if only half as much of a third clay is required, its relative colloid content is 200, etc. The plasticity of clays is given by the expression: relative colloids $\times$% air shrinkage divided by surface factor. The surface factor is a number proportional to the total area of the grains in a given weight of clay. The malachite green oxalate test fails in the presence of $CaCO_3$ or free alkali. Measurements are given for a large number of commercial clays. (*Chem. Abs.*, **5**, 174 (1911).)

Ashley, H. E.

TECHNICAL CONTROL OF THE COLLOID MATTER IN CLAYS. *Trans. Amer. Ceram. Soc.*, **12**, 768 (1910).—The colloid matter of clays may be considered as consisting of complex mineral and organic acids and salts. There is a remarkable parallelism between the chemical behavior of these clay colloids and that of the fatty acids and soaps. The free acids and the salts with bivalent and trivalent bases are insoluble. The alkali compounds are soluble in pure water, but are readily salted out by excess of alkali or of salts of alkalis. Although so easily coagulated, the clay colloids are very readily reactive and exchange bases with salts and acids with greater ease than do soaps until equilibrium as determined by the mass-action law in the form commonly known as the adsorption equation, is attained. These principles have been tested on the most diverse types of clays and with some fifty reagents. The term "ge." applies to the free colloid acids to salts of bivalent and trivalent bases, and to salts of the alkalis when salted out. The term "sol" applies to salts of the alkalis when dissolved in water or other mediums. When clays are heated to about 300°, as in Bleininger's investigation of preheating clays to remove excessive stickiness, loosely combined water is driven off. The colloids lose to a considerable extent their property of shrinkage on drying but the organic and silicate members still retain their property of exchanging bases. Silicic acid and the hydroxides of iron and aluminum are more thoroughly rendered inactive. Diagrams are given illustrating the mass-action effect of alkalis in dissolving colloids and the quantitative effects of alkaline precipitants. The principal difficulty in soluble-salt determination in clays is to know when to stop. After such salts as calcium, magnesium, sodium sulphates, and sodium chloride have been removed by successive extractions with cold water, then without a break (or rather with decided overlapping) alkaline silicates of more or less colloidal character are removed. A method of soluble-salt determination is suggested. The use of barium carbonate to prevent scum on clay wares is discussed in regard to determining the amount to be used. The preparation of

clays for mechanical or sizing analysis is accomplished by dissolving the colloid coatings from the granular matter. Excess of water dissolves the crystal grains. Excess of solvent also makes trouble. Pottery casting slips require less water and make denser products when a portion of the colloid content is in the soluble form. This is secured by the addition of alkalis or alkali precipitants. Clays may be improved by adding or removing colloid matter and by exchanging the bases in the colloid matter. Fullers' earths are clays of high colloid content. By treating with salts or acids, any desired base may be put into them. By heating or coking, their shrinkage may be eliminated and their structure rendered porous. By extracting the colloids from clays with alkalis, and then coagulating the extract with acids, with salts of bivalent or trivalent bases, or by evaporation, artificial fullers' earth may be prepared. (*Chem. Abs.*, **5**, 174 (1911).)

***Ashley, H. E.**

See Bleininger, A. V., and Clark, H. H. (this *Bibliography*, p. 27).

Athenstaedt, W.

COOLING AND DISINTEGRATION OF BLAST-FURNACE SLAG AND ENAMEL FRIT. *Keram. Rundschau*, **34**, 538 (1926).—Enamel frit may be cooled similar to blast-furnace slag. Granulated, steam-cooled, blast-furnace slag is in such condition that it can be easily ground and enamel frits can be similarly cooled to advantage. (*Ceram. Abs.*, **5**, 343 (1926); *Chem. Abs.*, **20**, 3220 (1926).)

Atkinson, Wm., and Smith, Joseph

ENAMELING METALS. U. S. Pat. 843,985, Feb. 12, 1907; British Pat. 12,554, May 30, 1906.—A flux of white opal cullet 130 parts, sodium bicarbonate 20, and boric acid 12 is ground in water to a fine powder, applied to the article, and fired. (*Chem. Abs.*, **1**, 919, 938 (1907); *Chem. and Ind.*, **25**, 1147 (1906).)

Atterberg, A.

PLASTICITY AND COHERENCE OF CLAYS AND LOAMS. *Chem.-Ztg.*, **34**, 369 (1910).—The lower limit of fluidity and upper limit of plasticity are identical. To determine this 6 to 10 g. of clay, passing a sieve of 0.2 to 1.0 mm., are put into a small dish with water; more clay is worked in until a V-shaped cut across the mass does not flow together, shortening the point of the V, even on striking the dish. This limit is not sharp with heavy clays. If more clay is gradually added and the mass worked with a nickel spatula, a sharp limit of stickiness is reached, at which no clay adheres to the spatula. The upper limit of formability depends on the two preceding limits, for shaped ware must not stick or flow. The lower limit of plasticity is determined by taking some of the damp clay from the dish, rolling it out by the fingers on paper into fine "threads," collecting and rerolling until the clay has lost so much water that it falls to pieces on rolling (it must be rolled so as continually to increase in length). The limit of cohesion is that at which so much water is lost that the clay can no longer be pressed into balls (about 6 to 8% less water is in the clay than at the limit of plasticity). The limit of shrinkage is determined by drying slowly, weighing every hour or two, measuring the distance between two scratches until shrinkage ceases, then drying at 110° to constant weight. The upper and lower limits of plasticity and the stickiness limit suffice to characterize a clay. The fluidity limit is most essential with a soil. Equally deformable clays may differ in the amount of sand they can take up without losing plasticity. Clay is of first-class plasticity if it remains plastic when mixed with twice its weight of sand of 0.3 to 1.0 mm. diameter; second class with equal weight; third class with less than equal weight. There are no first-class clays rich in humus. The difference be-

tween the upper and lower limits of plasticity (plasticity difference) is greatest with first-class clays. When the plasticity difference is zero, the soil is nonplastic, and is to be considered a loam. Coherence is measured as the load required upon a knife to split a 2-inch cube dried at 110°. (The coherence of a given clay varies greatly with water content, *e.g.*, water per 100 clay: kg., 42:0.179, 36:0.342, 30:0.910, 25:7, 20:22, 0:45. Therefore, coherency tests are made with water content equal to zero). The cubes are made oversize, and polished to size after shrinkage is over, but before dry. The plasticity difference gives an approximate measure of true plasticity. The very high water content of several clays is explainable, for these clays have high humus content, fine kaolin, or mica dust. A table gives results on thirty-one clays and farm soils. Coherency is low with nonplastic loams. The clays of first-class plasticity have the finest size of grain in largest amount, but the converse is not true. Higher content in fine sand (0.2 to 0.02 mm. diameter) does not lessen the coherency as strongly as higher content in rock dust (0.02 to 0.002 mm.). (*Chem. Abs.*, **4,** 2558 (1910).)

Atterberg, A.

PLASTICITY OF CLAY. *Intern. Mitt. Bodenk.*, **1,** 4; through *Tonind.-Ztg.*, **35,** 1460.—The following points were taken as characteristic of a clay: (*a*) The "upper limit of flow," which is the composition where a mixture of clay and water is fluid; (*b*) the "lower limit of flow," where two drops of the mixture in a dish cannot be made to unite by jarring the dish; (*c*) the "limit of stickiness," where the clay no longer sticks to the fingers; (*d*) the "limit of ductility," where the clay cannot be rolled into threads or rolls; and (*e*) the "limit of cohesion," where two moist lumps will not stick together. On determining these for 75 clays and loams, (*d*) seems to be the best qualitative indication of plasticity as commonly understood. This must lie below (*i.e.*, with less water than) (*b*). Loams may often be rolled out above (*b*); this is called the "plasticity half-liquid substances," and is not true plasticity. Changes of temperature have a slight effect. Plasticity may be measured by the difference in composition at (*b*) and (*d*) measured at 16 to 20°. The composition at (*c*) is the normal composition for ceramic technique. For most plastic clays it lies between (*b*) and (*d*), dividing the plasticity into two kinds, sticky and nonsticky. If it lies below (*d*) the clay is difficult to work, but may be improved by adding sand or very small amounts of organic substances. (*Chem. Abs.*, **6,** 1060 (1912).)

Auerbach, R.

Zsigmondy Festschrift, **36,** 252.

Auger, M.

ENAMELING METAL ARTICLES. British Pat. 254,452, May 5, 1925.—To produce a surface to which vitreous enamels will adhere on brass and similar yellow metal alloys, without the application of a copper coating, the alloy is treated with an acid (nitric acid, or a mixture of nitric and sulphuric acids), or a pickle (sodium chloride) to dissolve the metals, with the exception of the copper, from the surface. A practically pure copper surface is thus produced. (*Ceram. Abs.*, **6,** 52 (1927); *Chem. Abs.*, **21,** 2543 (1927); *Chem. and Ind.*, **45B,** 918 (1926).)

Auger, R. A.

ENAMELING BRASS OR LIKE METAL. British Pat. 251,327, Jan. 27, 1925.—Brass water taps or like articles of similar yellow metal are electroplated with Cu; this is deposited slowly, heated to expel any gases in the coating, and then coated with a vitreous enamel. (*Chem. and Ind.*, **45B,** 586 (1926); *Ceram. Abs.*, **6,** 266 (1927); *Chem. Abs.*, **21,** 1338 (1927).)

***Aupperle, J. A.**

ENAMELING METAL See Beck, Wesley J. (this *Bibliography*, p. 17).
ZIRCONIA IN ENAMELS. See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 41).

Aupperle, J. A., and Brooks, Howard

DEVELOPMENT OF SHEET METAL FOR VITREOUS ENAMELING. *Ceramist*, **4**, 294 (1924).—The production and properties of Armco iron for enamel stock. It has been found desirable to keep the carbon content about 0.01%, manganese below 0.03%. The microstructure of ingot iron, mild steel, wrought iron, and welded ingot and mild steel is discussed with particular reference to their use as enamel stock. (*Ceram. Abs.*, **4**, 61 (1925).)

Ausfahl, R. J.

ENAMELING IN SOUTH AMERICA. *Enamelist*, **4** [3], 6 (1926).—Practically all articles used in the enameling industry are imported with the possible exception of acids.

***Babille**

RESEARCH ON GLASS OPACIFIERS. See Granger, A. (this *Bibliography*, p. 135).

Bablik, H.

PICKLING IRON. *Stahl u. Eisen*, **46**, 218 (1926).—Pickling effect is greater in sulphuric acid than in hydrochloric acid, and less acid is required, but the pickling period is longer. Pickling velocity of hydrochloric acid rises continuously with increasing concentration for sulphuric acid; maximum velocity is at 25%. At 60°C the pickling velocity of both acids is increased ten-fold. The velocity is decreased by the presence of reaction products; the amount of chlorides to be washed out is less than the amount of sulphates. Boiling water should be used for complete removal. Pickling with hydrochloric acid is handier and simpler but more expensive. By the use of Vogel's "VBZ" reagent, a saving in iron and acid is effected, and a smoother surface is imparted to the iron. (*Ceram. Abs.*, **5**, 344 (1926).)

de Back, A.

RECOVERING IRON AND STEEL FROM WASTE ENAMELED ARTICLES. British Pat. 3375, Feb. 11, 1910.—The articles are first pressed together to crack the enamel and then cut into strips, which being pushed against suitably-shaped scrapers, are thereby distorted and sufficiently opened to allow the enamel to fall away. (*Chem. and Ind.*, **29**, 1390 (1910).)

de Back, A.

RECOVERING IRON AND STEEL FROM WASTE ENAMELED ARTICLES. U. S. Pat. 1,126,621, Jan. 26, 1915; British Pat. 77, Jan. 1, 1913.—The enameled articles are passed successively through pairs of rollers so arranged that the perimeter of any pair is greater than that of the preceding pair. The articles are thus not only bent and distorted but also stretched, and the enamel thereby becomes broken and loosened. (*Chem. and Ind.*, **32**, 607 (1913); *ibid.*, **34**, 235 (1915); *Chem. Abs.*, **8**, 2235 (1914).)

de Back, A.

RECOVERING IRON AND STEEL FROM WASTE ENAMELED ARTICLES. U. S. Pat. 1,196,342, Aug. 29, 1916.—The method of removing enamel from waste enameled articles, which consists in compressing the articles and crushing the enamel thereon and positively opening the layers of the articles to permit removal of enamel between the layers.

de Back, A.

APPARATUS FOR DISINTEGRATING METAL ARTICLES. U. S. Pat. 1,196,343, Aug. 29, 1916.—Waste enameled metal articles are passed between at least two pairs of rollers, the first pair having circumferential ribs and the second pair longitudinal ribs. The circumferential speed of the second pair is greater than that of the first pair so that a tension is exerted on the articles between the two pairs of rollers which corrugate the articles in two directions at right angles. (*Chem. and Ind.*, **35**, 1022 (1916).)

Back, Robert

EFFECT OF SOME ELECTROLYTES ON CLAY. *Trans. Amer. Ceram. Soc.*, **16**, 515 (1914).—The effects of various electrolytes were studied on clays mixed to four consistencies: (1) plastic mass, (2) a pastelike vaseline, (3) a sliplike cream, (4) 5 g. in 100 cc. of water. Results: (1) The cause of the dual behavior of electrolytes is to be sought in dissociation phenomena and changes in surface tension of the liquid medium. (2) Varying shrinkage and pore-water volume relations can be attributed to the effect of reagents on arrangement of the clay particles, or to a change in their holding water above 110°. (3) Very small amounts of electrolytes produced profound effects. (4) The coagulating power of neutral salts and also the rapidity of coagulation increased with their valence. (5) In viscosity work great precautions, especially in drying methods and in time range, must be observed. (6) Neutral salts, as well as acids and alkalis, have decided influence on shrinkage and viscosities of clays. (7) In proportions less than about 0.05 to 0.075%, $Ca(OH)_2$ and $Ba(OH)_2$ act as deflocculators, but greater concentrations have a decided flocculating effect, the $Ca(OH)_2$ being of greater influence with the two clays tested. (8) NaOH and KOH are vigorous deflocculating agents for all concentrations, although with some clays a temporary thickening effect appears, due probably to the presence of CaO or other stabilizing agent. (9) Atomic weights of the elements and consequently migration of their ions govern largely the rapidity of reaction for colloidal clay solution. (*Chem. Abs.*, **8**, 3713 (1914).)

***Backstrom, H.**

ANOMALIES IN HEAT CONDUCTION IN STEEL. See Benedicks, C. (this *Bibliography*, p. 17).

Baezner, C.

OPAQUE ENAMEL OR GLAZING COMPOSITION FOR USE ON SHEET IRON, ETC. U. S. Pat. 1,153,748, Sept. 14, 1915.—Formed of a vitrifiable mixture as usually employed, mixed with about 5% of zinc sulphide having luminous properties. The latter gives the glazing a phosphorescent property. Ordinary zinc sulphide may be used for opaquing if a phosphorescent glaze is not desired. (*Chem. Abs.*, **9**, 3343 (1915); *Chem. and Ind.*, **34**, 1055 (1915).)

Bagnall, A.

ENAMELING COMPOSITION. U. S. Pat. 556,727, March, 24, 1896.—A composition for enamel, consisting of feldspar, whiting, flint, oxide of zinc, boracic acid, china clay, and oxide of tin, fused to a homogeneous mass and powdered in water.

Bair K. u. Gwbl., p. 148 (1843).

NEW PORCELAIN ENAMEL. (*Rep. der. Tech. Lit.*, p. 272 (1823–1853).)

Bair K. u. Gwbl., p. 571 (1859).

ENAMEL ON CAST IRON. (*Rep. der. Tech. Lit.*, p. 306 (1854–1868).)

***Baker, Theodore**

ENAMELED WARE. See Whittaker, Harold F. (this *Bibliography*, p. 334).

Ballouhey

ENAMELING CAST AND WROUGHT IRON. *Dingler's polytech. J.*, **184**, 374; (*Rep. der Tech. Lit.*, p. 306(1854–1868)).

Bancroft, W. D., and Jenks, L. E.

PLASTICITY OF CLAY. *Jour. Phys. Chem.*, **29**, 1215 (1925).—The problem was to find out whether any electrolyte would make and keep a nonplastic clay plastic when added in moderate amounts. As a nonplastic clay, kaolin was used. It was found that addition of about 0.25% of lithium salt, usually lithium chloride, together with a little sodium chloride, gave kaolin a higher plasticity than any of the ball clays tested. No firing experiments were made. No connection was found between the plasticity of clays and their lithium content and it is probable that the plasticity of clay is due to the combined effect of humus and some electrolyte. (*Ceram. Abs.*, **5**, 65 (1926).)

Banning, B.

SECURING ENAMELED PLATES IN POSITION. U. S. Pat. 777,656, Dec. 20, 1904.—In a sheathing, the combination with a sheet-metal plate having a plurality of pockets pressed therein to form ribs between the pockets, of a plurality of plates shaped conforming to the shape of the pockets to rest snugly therein and means for securing the plates in the pockets, the means being adjustable to permit of the plates being removed from the pockets.

Banning, Grace M.

METAL ENAMELING. U. S. Pat. 869,155, Oct. 22, 1907.—The process of decorating metal, which consists in first punching holes in the metal in such a manner as to provide burrs, and then applying enamel to the rear side of the metal, allowing the enamel to fill into the burred holes, the latter affording sockets for the retention of the enamel.

Bannister, C. O.

IRON AND STEEL IN 1926. *Ann. Rept. Soc. Chem. Ind.*, **11**, 252 (1926).—Review of some articles on pickling. Progress is reviewed under the headings (*a*) production foundry practice, (*b*) manufacturing of steel, (*c*) cementation and case hardening, (*d*) properties of iron and steel, and (*e*) corrosion.

Baranoff, A. von

PLASTICITY OF CLAY. *Z. tech. Physik*, **7**, 191 (1926).—Some previous conclusions were verified by compression of a clay cylinder. It is shown in a triangular diagram for the ternary mixture of clay-sand-water that plasticity is limited on one side by a "pap" region, on the other side by crumbling mixtures. Experiments are tabulated on compression of several mixtures. (*Chem. Abs.*, **20**, 2568 (1926).)

Bardenheder, P., and Ebbefeld, C.

SHRINKAGE IN WHITE AND GRAY IRON. *Stahl u. Eisen*, **45**, 825–1022 (1925).—Wust's apparatus was modified to eliminate errors due to heating of the shrinkage transmission wires. The initial expansion of iron on solidification is closely associated with the gas content of the iron, and is caused by the sudden drop in solubility of the gases at the solidification point. Shrinkage of gray iron is less than that of white iron, the difference occurring chiefly in the prepearlitic period, in which secondary graphite is deposited. The postpearlitic shrinkage is approximately the same in each case. Alloying elements affect shrinkage by their influence on the secondary graphite deposi-

tion, an element which assists deposition causes, less prepearlitic, and therefore, less total shrinkage. Silicon diminishes while manganese and sulphur increase shrinkage. Phosphorous up to 3% does not influence cast-iron shrinkage, it prolongs the solidification interval. By heating the mold the prepearlitic shrinkage may be reduced to nil, a practice of value in preventing strains and cracking of castings. The hardness and tensile strength of the iron are diminished by this process, but the bending strength is not affected. (*Ceram. Abs.*, **5**, 12 (1926); *Chem. and Ind.*, **44B**, 634 (1925).)

Bardush, John

THIRTY-FIVE YEARS AN ENAMELER. *Ceram. Ind.*, **6**, 482 (1926).—Many changes have taken place in enameling plants during thirty-five years. Labor is inferior and standard of enameling lower. Oil should be run through an 80-mesh sieve. It will give greater heat value and more complete combustion—if free from débris. The carbon content of clay should also be observed. The following formulas are given:

I. Enamel with Good Appearance but without Much Gloss

Feldspar	245	Antimony	10	(%)
Flint	151	Saltpeter	15	4 Clay ("0" clay)
Kryolith	121	Fluorspar	23	4 J. P. clay
Borax	189	Zinc	27	3 Tin
Soda ash	24	Lead	15	40 Water

II. Another Enamel without High Gloss

Feldspar	198	Antimony	23	(%)
Flint	120	Saltpeter	23	7 J. P. clay
Kryolith	105	Fluorspar	23	4 Tin
Borax	173	Lead	23	40 Water
Soda ash	23	Opax	30	

III. Good Cover Coat

Feldspar	100	Soda ash	49	(%)
Flint	78	Kryolith	20	5 Valender clay
Borax	105	Fluorspar	45	5 Tin
Antimony	20	Saltpeter	25	

IV. Ground Coat

Borax	204	Fluorspar	36	(%)
Feldspar	156	MnO_2	3	6 Valender clay
Flint	132	CoO	1.5	40 Water
Soda ash	42	Green NiO	1.0	
Saltpeter	30			

High Content of Nickel Causes Chipping in the Following Formula:

Borax	150	Fluorspar	10
Feldspar	135	MnO_2	5
Flint	66	CoO	1.5
Soda ash	12	NiO	8.0

***Bardush, John**

SPRAYING BOOTH KEPT FREE OF ENAMEL DUST BY UNIT SUCTION SYSTEM. See *Ceram. Ind.* (this *Bibliography*, p. 58).

EFFECT OF MUFFLE ATMOSPHERE ON FIRING ENAMELS. See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 43).

Barringer, E. C.

CLEANS CASTINGS HYDRAULICALLY. *Foundry*, **53**, 951 (1925).—The Allis-Chalmers Co. clean their castings with water under 425 pounds pressure. The pressure is developed

with a 4-inch, 6-stage, centrifugal pump driven by a 300 H.P. motor, delivering 800 gal. of water per minute at a 900-ft. head. The castings are placed in a concrete room, in whose walls the nozzles are fastened. The operator stands outside the room and watches the work through reinforced glass windows. The water is cleaned and recirculated. As an example of the saving obtained, a casting which formerly required 300 hours to clean is now cleaned in 14 hours. Two men are doing the work that used to require sixty. (*Ceram. Abs.*, **5,** 46 (1926).)

Barringer, L. E.

TESTING ENAMELED SHEET-STEEL WARE. *Trans. Amer. Ceram. Soc.*, **11,** 338 (1909).—The method is described for testing enameled articles where the enamel is intended as electric insulation.

Barringer, L. E.

APPLICATION OF ELECTRIC HEAT TO VITREOUS ENAMELING. *Jour. Amer. Ceram. Soc.*, **4,** 461 (1921).—A two-compartment open-chamber furnace with separating door operated from the outside is described. The source of heat is an electric current passed through a nichrome resistor ribbon wound over refractory supports arranged along the sides of the furnace. The front or preheating compartment is operated at 300°C and the back or finishing compartment at 900°C, with automatic control. The advantages, compared with oil heating, are (1) rejections reduced from 25% to 0; (2) 50% increase in output for same floor space; (3) 47.4% lower fuel cost; (4) improved quality and uniformity; and (5) lower maintenance cost and greater ease of operation. (*Chem. Abs.*, **16,** 150 (1922); *Chem. and Ind.*, **40A,** 772 (1921).)

Barringer, L. E.

ELECTRIC VITREOUS ENAMELING FURNACE. See *Chem. Met. Eng.* (this *Bibliography*, p. 65).

Bartel, P.

INVESTIGATION OF SOLUBILITY OF LEAD IN FRITTED GLAZES. *Sprechsaal*, **51,** 25, 31, 35, 39, 43 (1918); *Z. angew Chem.*, **31** [1], 290 (1918).—B. subjected frits with a composition ranging from $PbO{\cdot}1.5SiO_2$ to $PbO{\cdot}4SiO_2$ which had been ground to pass completely through a No. 175 sieve, to the action of 4% AcOH under the conditions of the German official test, for determining the solubility of lead in glazed ware. The resistance of the glaze to the acid was not proportional to the SiO_2 content of the glaze, but increased with the SiO_2 content up to 2.5 mols. SiO_2 per mol. PbO and then diminished with more siliceous glazes. When a part of the PbO was replaced by soda, potash, lime, baryta, magnesia, or zinc oxide, less lead was dissolved by acetic acid. On the addition of Al_2O_3 to the material used for the frits, the solubility of the lead was still further diminished and was reduced to nil in several frits containing either Na_2O, K_2O, CaO, BaO, MgO, or ZnO. Of the 817 frits examined, 430 yielded less than 2% of lead to the acetic-lead solution; of these 11 were simple lead silicates Al_2O_3, 79 containing soda, 64 potash, 74 lime, 50 baryta, 85 magnesia, and 67 zinc oxide. These frits contained the following amounts of silica:

No. of frits	No. of mols.	No. of frits	No. of mols.
14	1.50	52	3.00
24	1.75	39	3.25
37	2.00	37	3.50
47	2.25	42	3.75
48	2.50	41	4.00
49	2.75		

Most of the frits which contained $1.5SiO_2$ were clear, but those containing 2.75 or more SiO_2 were seldom so. The addition of boric acid to reduce the viscosity and the melting point of the frit was unsatisfactory. (*Chem. Abs.*, **14**, 604 (1920).)

Bassett, Z. D.

FUEL OIL IN ENAMEL AND POTTERY INDUSTRY. *Ceram. Ind.*, **8**, 458 (1927).—Gives advantages of fuel oil over coal. There are several methods of burning oil: the high oil pressure or mechanical system, the compressed air and steam system, and the low pressure air system. The best combination is the low pressure air, low pressure oil system, that is, with the oil furnished at 15 to 25 pounds pressure, and the air at from 8 to 12 ounces, the flame developed is fully as hot as the high pressure air flame but furnishes a much more even distribution of heat and does not have the cutting effect; a much closer control of draft is obtained with the low pressure air system. (*Ceram. Abs.*, **6**, 235 (1927).)

Bauer, P.

ACTION OF ZINC OXIDE ON UNFRITTED LEAD-FREE ENAMELS FOR SANITARY ENAMELED WARE. *Ber. deut. Keram. Ges.*, **3**, 286 (1922); *Chimie et ind.*, **12**, 1067 (1924).—After studying several enamels of the type: $0.3K_2O$, 0.7MO, 0.4 to $0.5Al_2O_3$, $4SiO_2$, in which MO was replaced by ZnO and CaO, Bauer considers the following as the most interesting: $0.7ZnO$, $0.3K_2O$, $0.5Al_2O_3$, $4SiO_2$. (*Ceram. Abs.*, **5**, 46 (1926); *Chem. Abs.*, **19**, 1039 (1926).)

Baumann

ENAMELING IRONWARE. French Pat. 356,736, Aug. 7, 1905.—Process of enameling ironware, consisting in so firing the mixtures of enamel containing phosphoric acid with enamels containing alkaline earth compounds that the alkaline earth phosphate is formed during the process. (*Chem. Abs.*, **1**, 511 (1907).)

Baumann, Gebr.

APPARATUS FOR CLOUDING ENAMELS. German Pat. 286,037, April 22, 1914.—The clouding process is mechanical. (*Chem. Abs.*, **10**, 1701 (1916).)

Beasley, Herbert Charles

ENAMELING FURNACE. U. S. Pat. 1,526,582, Feb. 17, 1925.—In an enameling furnace a firing or fusing chamber embodying means for raising the temperature therein to an enamel fusing point, a preheating chamber situated at one end thereof, a cooling chamber situated at the other end of the firing chamber, means for passing articles successively through the preheating chamber, fusing chamber, and cooling chamber, and means for controlling, to a predetermined degree, the cooling effect of the cooling chamber, the last means comprising a conduit through which a heat-absorptive medium may be passed. (*Ceram. Abs.*, **4**, 99 (1925); *Chem. Abs.*, **19**, 1337 (1925); *Chem and Ind.*, **44B**, 319 (1925).)

Beasley, Herbert Charles

ANNEALING FURNACE. U. S. Pat. 1,526,583, Feb. 17, 1925.—The method of annealing articles which comprises utilizing the heat stored in annealed articles to heat articles to be annealed while the articles are in an oxidation-preventing atmosphere. (*Ceram. Abs.*, **4**, 99 (1925).)

Beasley, H. C., and MacDougall, R.

FURNACE FOR ENAMELING METALWARE. U. S. Pat. 1,603,014, Oct. 12, 1926.—A furnace comprising a central heating chamber, a pair of preheating chambers located

one at either end of the heating chamber, and a pair of drying chambers communicating each with one of the preheating chambers, the central chamber being formed into two separate chambers, the preheating and drying chambers being formed each in one chamber. (*Ceram. Abs.*, **5,** 385 (1926); *Chem. Abs.*, **20,** 3790 (1926).)

Beasley, H. C., and MacDougall, R.

FURNACE AND OVEN FOR FUSING ENAMELWARE. U. S. Pat. 1,603,015, Oct. 12, 1926.—In combination with an oven having a slot in the roof thereof, a hood overlying the slot and means for preventing the escape of heated air through the slot, including the hood, and an air supply and conduit system adapted to force air under pressure into the hood. (*Chem. Abs.*, **20,** 3790 (1926).)

Beck, Wesley J., and Aupperle, James A.

ENAMELING METAL. U. S. Pat. 1,578,706, Mar. 30, 1926.—An article used for receiving a coating of enamel in the presence of heat, formed of open hearth or similar ingot iron refined to a stage where the manganese content is below 0.04% and degasification has taken place to the extent of leaving a substantially sound metal, and not to the extent of eliminating all of the oxide content, the iron exhibiting under the microscope numerous well-distributed spots of oxide in the surface and through the body thereof. (*Ceram. Abs.*, **5,** 176 (1926); *Chem. Abs.*, **20,** 1701 (1926); *Chem. and Ind.*, **45B,** 408 (1926).)

***Beckwith Co.**

HISTORY OF THE BECKWITH CO. See *Enamelist* (this *Bibliography*, p. 110).

Belaiew, N. T.

INNER CRYSTALLINE STRUCTURE OF FERRITE AND CEMENTITE IN PEARLITE. *Proc. Roy. Soc.*, **108A,** 295 (1925).—Cementite lamellas, under magnification 4000, are petal-like in shape and curvature, but the edge is usually composed of rectangular steps, which are of uniform size, and point to the conclusion that cleavage occurs through a definite line or unit. Ferrite lamellas show small isolated cubes, the edge of the cube being about 250 $\mu\mu$; their dimensions are about the same in alloys of different carbon content. It is suggested that every ferrite lamella is built up of such cubes, suitably oriented. Every pearlite grain has been subject to stress by the change of iron from face-centered to cube-centered lattice. These stresses give the cementite lamellas their curved form, and split the ferrite lamellas into a multitude of cubes. (*Ceram. Abs.*, **5,** 12 (1926); *Chem. and Ind.*, **44B,** 635 (1925).)

***Belding Hall (Mich.) Co.**

BURNER CHANGE INCREASES PRODUCTION. See *Ceram. Ind.* (this *Bibliography*, p. 58).

***Belleville (Ill.) Enameling and Stamping Co.**

SAVE 4000 POUNDS WASTE ENAMEL MONTHLY. See *Ceram. Ind.* (this *Bibliography*, p. 56).

Benedicks, C., Backstrom, H., and Sederholm, P.

ANOMALIES IN HEAT CONDUCTION IN STEEL. *Engineering*, **122,** 302 (1926).—Steel spheres were found to vary in thermal conductivity by as much as the ratio 1:8.5, the electrical resistivity difference being only 1:1.05. The authors consider that much of the heat transfer is occasioned by thermoelectric convection currents. The thermal conductivity (λ) of pure iron is given as 0.187, a result somewhat higher than that of other workers. The influence on λ of added dissolved elements is in the order: Ni, Mn,

hardening C, Al, Si. Thus 1 atomic per cent of Ni lowers λ less than a similar quantity of Mn, and so on. (*Ceram. Abs.*, **6**, 51 (1927).)

***Benjamin Electric Mfg. Co.**

ENAMEL PLANT APPLIES MODERN TOOLS OF BUSINESS TO WIN SUCCESS. See *Ceram. Ind.* (this *Bibliography*, p. 50).

Benjamin, G. H.

ENAMELING KILN. British Pat. 143,974, March 6, 1919; U. S. Pat. 1,311,487, July 29, 1919.—The bath tubs or other ware to be enameled are placed upon trucks and passed successively through a preliminary heating chamber, a coating or enameling chamber, and a secondary heating chamber, the temperature gradually increasing in the preliminary heating chamber and gradually decreasing in the secondary. During the enameling proper, heavy doors shut off all communication between the coating and heating chambers so that workmen may enter and sprinkle on the enamel without any considerable discomfort. (*Jour. Amer. Ceram. Soc.* (Abs.), **2**, 852 (1919); *Chem. and Ind.*, **38A**, 723 (1919); *ibid.*, **39A**, 519 (1920).)

Bentz, J.

ENAMELING METAL SURFACES. U. S. Pat. 596,317, Dec. 28, 1897.—The process of enameling metal surfaces, which consists of coating the metal article with a foundation-coat of enameling composition; applying to the coat while it is still moist, artificial crystal-stone composition in the form of stripes, grains, pebbles, or other fanciful form, so as to embed the same in the foundation-coat, but have the inlaid particles projecting slightly; then subjecting the metal article to heat in a baking oven so that one baking will develop the foundation-coat and merge the artificial crystal-stone composition therein and produce a cameo effect.

Berg

ENGLISH ENAMEL FOR CAST IRON. *Ztg.*, p. 20 (1867); (*Rep. der Tech. Lit.*, p. 306 (1854–1868)).

Berge, A.

LEADLESS ENAMELS AND FAIENCE WITH REDUCED CONTENT OF TIN OXIDE. *Sprechsaal*, **46**, 17 (1913).—For producing opacity in enamels, the proposed substitutes for tin oxide which is effective but costly, are cryolite, "artificial cryolite," sodium silicofluoride (a by-product in the manufacture of superphosphate), antimony oxide, titania, zirconia, and frits containing fluorides, none of which solve the problem, while "tin ashes" contain lead oxide and are poisonous. Instead of dispensing entirely with tin oxide, B. proposes to reduce it to a minimum by fritting with sodium phosphate, the molecular formula recommended being: 2.4 SiO_2, 0.1 SnO_2, 0.2 Al_2O_3, 0.45 B_2O_3, 0.2 P_2O_5, 0.4 MgO, 0.2 K_2O, 0.4 Na_2O. (*Chem. and Ind.*, **32**, 142 (1913).)

Berge, A.

ENAMEL GLAZES FREE FROM LEAD AND TIN. *Sprechsaal*, **47**, 339 (1914).—Antimony compounds are used as a substitute for the more costly tin oxide in producing opacity; they have not as yet been unanimously condemned as poisonous. The following molecular formulas are given for glazes fired at cone 010 with an addition of 7.5% of Sb_2O_3 and found after 10 weeks to be free from crazing:

	1	2	3	4	5
SiO_2	2.8	2.0	3.0	3.2	3.0
Al_2O_3	0.25	0.20	0.30	0.1	0.2
B_2O_3	0.30	0.50	0.46	0.6	0.5
K_2O	0.50	0.20	0.30	0.1	0.2

	1	2	3	4	5
CaO	0.50		0.27	0.2	0.15
Na_2O		0.25	0.20	0.3	0.25
MgO		0.10		0.23	
BaO		0.45			0.10
SrO			0.30	0.20	0.30

(*Chem. Abs.*, **8**, 3493 (1914); *Chem. and Ind.*, **8**, 647 (1914).)

Berndt, M.

STATUS OF COBALT IN GROUND COAT OF SHEET-STEEL ENAMEL. *Keram. Rundschau*, p. 262 (1914); *Silikat Z.*, **2**, 160(1914).—A small addition of cobalt oxide or nickel oxide to the ground coat causes it to adhere more firmly to the metal. Tostmann says this is due to the reduction of the iron to the metallic state. B. observes that enamels transparent *per se* appear as opaque coverings on the metal, if they do not contain the heavy metallic oxides. This is due to the presence of numerous small bubbles. The side of the ground coat next to the metal exhibits a black layer with numerous small pits or depressions. The bubbles explain the poor adherence of the coating to the metal. The bubbles are caused by the evolution of oxygen which takes place in the oven when the Fe_2O_3 changes to FeO. If the enamel contains cobalt oxide, the latter is oxidized by this oxygen to Co_2O_3, thereby preventing formation of bubbles and causing stronger adherence of enamel. (*Chem. Abs.*, **8**, 3847 (1914).)

Berninghaus, Eugene

METHOD OF ENAMELING. U. S. Pat. 1,452,635, April 24, 1923.—The method of producing enameled chair sections which comprises applying an annular coating of fused enamel to the exterior of an annular sheet metal chair section having inwardly turned, opposite edges by rotating the section with its exterior surface including portions of the inwardly turned edges in contact with a bath of fused enamel. (*Ceram. Abs.*, **2**, 149 (1923).)

***Berquist, Carl**

CONSISTENCY OF STARCH AND DEXTRIN PASTES. See Herschel, Winslow H. (this *Bibliography*, p. 153).

Berthelier, A. J. A.

FURNACE FOR BAKING ENAMELS, GLASSWARE, AND PORCELAIN. British Pat. 16,550, July 29, 1898.—This furnace has two muffles, placed one above the other, made of cast iron or fire clay, according to requirements. By means of a separating plate with apertures and a longitudinal partition, the hot gases are made to travel around the muffles before escaping by the chimney. Vertical flues are arranged at the corners to accelerate the draft, and to convey a portion of the heated gases directly to the top of the upper muffle. The furnace also has movable bars, to allow the fire to be dropped when the proper degree of baking has been reached. (*Chem. and Ind.*, **17**, 1148 (1898).)

Bertrand, M. V.

ENAMELING AND GLAZING OF PORCELAIN FAIENCE, STONEWARE, METAL, AND OTHER SURFACES. French Pat. 449,208, Oct. 10, 1912.—Lead compounds are replaced by chalk, borax, and the carbonate, chloride, and sulphate of sodium. (*Chem. and Ind.*, **32**, 488 (1913).)

Bertrand, M. V.

ENAMELS OF SODIUM BOROSILICATE. *La Céramique*, **16**, 113 (1913).—Borax, sodium carbonate, sodium sulphate, and sodium chloride are fused together, 20% of

water added to cooled mass and the whole allowed to crystallize in seven or eight days. These crystals are used in the same way as red lead for an enamel or glaze. The alkali fused with the borax eliminates the effervescent property of the latter and the acid radicals affect the crystallizing property of the product, which results in an amorphous, pliable mass, when mixed with sand. (*Chem. Abs.*, **7**, 2841 (1913).)

Bickmeier, C.

CONTINUOUS FURNACE FOR FIRING ENAMELWARE. Canadian Pat. 172,606, Oct. 17, 1916; *Chem. Abs.*, **12**, 525(1918).

Bickmeier, Charles, and Liston, Daniel A.

CONTINUOUS-FIRING FURNACE FOR FIRING ENAMELWARE. U. S. Pat. 1,140,105, May 18, 1915.—The furnace bottom consists of two blocks, spaced apart, and having their upper surfaces curved downward and backward from the middle line of the furnace. The cover of the furnace has on its underside a depending tongue in the middle and curved portions on each side of the tongue. Below the furnace is a buggy from which a standard projects upward through the furnace bottom; at the top the standard carries a 3-armed frame from which rise fingers with finely pointed tops for supporting the ware within the furnace. (*Chem. and Ind.*, **34**, 717 (1915).)

Biddell, W. A.

PROCESS FOR ENAMELING. British Pat. 13,029, Oct. 1, 1884.—This patent refers to means for coating iron and steel surfaces with vitreous enamels for various purposes and by various methods enumerated. (*Chem. and Ind.*, **4**, 746 (1885).)

Bigot, F.

MELTING FURNACES FOR ENAMELS. *Rev. mat. cons. trav. pub.*, **188**, 115–19B (1925).—Descriptions with drawings of two furnaces for melting enamels. They are of the stationary type, the enamel being melted on a hearth. (*Ceram. Abs.*, **4**, 244 (1925).)

Bingham, Eugene C.

PLASTICITY AS A MEANS FOR CONTROL OF PROPERTIES. *Jour. Amer. Ceram. Soc.*, **7**, 430 (1924).—(General discussion: no data.) (1) Research done thus far is enough to show that no single property such as tensile strength, adsorption of dye, or shrinkage can possibly be a measure of plasticity, for plasticity is a complex property made of two properties which are mutually independent. One of these properties may be an exact measure of the yield value or of the mobility but not of both at the same time. (2) Certain substances such as oleic acid, aluminum stearate, moisture, in very small amounts, have a great effect upon the yield value of paint with only a slight change in the mobility. In a similar way, it might be expected that small quantities of an oil or colloid would greatly affect the yield value of a clay slip. It has already been shown that the effect of small amounts of acid exert a prodigious effect on the yield value. (3) Temperature raises the mobility in the same ratio as the temperature raises the fluidity of the medium, but has no effect on the yield value. Other causes might change the mobility and not the yield value. With such prodigious effects upon, first, the yield value and then upon the mobility or sometimes on both, a knowledge of these properties will permit better control in the ceramic industry and it will disclose the means for obtaining properties in clay which are desired but which are now somewhat mysterious. (*Chem. Abs.*, **18**, 3261 (1924).)

Bingham, Eugene C.

PLASTICITY AND ELASTICITY. *Jour. Franklin Inst.*, **197**, 99 (1924).—Plasticity and elasticity are closely related. The stress-time curve for lead wire is given showing elastic deformation and recovery, pseudoplastic deformation and recovery, and plastic deformation. Stress-strain diagrams are misleading beyond the elastic limit if the time factor is lost sight of. Stress-strain diagrams of iron, rubber, steel, zinc, copper, and tin are explained. Glass is referred to. Instantaneous rigidity is the resistance to distortion extrapolated to zero time. There are objections to the use of the term resilience beyond the elastic limit, because the time element must be considered. Elastic after-effect is a kind of plastic flow. (*Ceram. Abs.* **3**, 204 (1924).)

Bingham, Eugene C.

PLASTIC FLOW. *Jour. Wash. Acad. Sci.*, **6**, 177 (1916).—The method of study was to force suspensions of clay in water under known pressure through capillaries of different dimensions and measure the flow. Some data are given. For medium pressures the volume of flow, $V = K(P - f)$, where V = volume, K a constant, P = pressure, and f = friction, *i.e.*, the force required to start flow. Putting $(P - f)$ in place of P in the ordinary Poiseuille formula for calculating fluidity gives a means of calculating mobility of plastic substances analogous to the fluidity of viscous substances. Friction increases as the linear function of concentration of the solid present and is independent of length and diameter of the capillary and of the viscosity of the medium. The mobility is profoundly affected by the presence of acids or alkalis in the medium. The mobility of a neutral clay, increased 330% with the addition of 0.1% K_2CO_3. At pressures little, if any, greater than those necessary to overcome the friction, seepage of the medium was noted past the solid particles. At high pressures rate of flow sometimes increased suddenly, apparently due to slipping. If solid materials were spheres, the pore spaces left would be about 26% regardless of the size of the spheres. Due to the friction of these spheres on each other the pore space is somewhat greater, especially so with fine-grained material. On shaking dry clay into a flask the pore space was found to be 81.6% of the total volume. The mixture having zero fluidity had 80.5% of liquid. It is upon this friction that plasticity depends and plasticity is thus closely related to the fineness of subdivision of the material. (*Chem. Abs.*, **10**, 1781 (1916).)

Bingham, Eugene C.

PLASTICITY IN COLLOID CONTROL. 2nd Colloid Symposium Monograph, p. 106.—B. stresses the importance of plasticity along the lines brought out in his book, Fluidity and Plasticity. By using long capillary tubes and properly evaluating seepage and slippage, the formula $V = \mu(F - f)r$ will probably be found to hold over a wide range of shearing stresses. Here μ is the mobility (the reciprocal of the consistency), F the shearing stress in dynes per sq. cm., and r the distance between the two shearing planes.

Notwithstanding that clear and indubitable evidence has now been found that in suspensions the flow is a linear function of the shearing stress, and the yield value obtained is quite independent of the dimensions of the instrument, nevertheless in colloids of the emulsoid type, evidence is found for exactly the opposite conclusions. The flow of emulsoids through a long capillary is not a linear function of the shearing stress, and the yield value cannot be obtained by simply extrapolating the flow-stress curve, for with capillaries of different radii nonconcordant values for the yield value would be obtained.

This evidence (to be published later) was obtained by Hood, Arnold, and B. To explain the sharp distinction between the two types of colloids, it must be recalled that internal friction is due to two causes: (1) diffusional viscosity, resulting from interdiffusion of molecules having different amounts of transitional energy, (2) collisional viscosity,

caused by actual spacial interference as the layers are sheared over each other. In liquids far removed from the critical temperature (1) (above) is of small importance, and the viscosity due to (2) follows Batschinski's law that fluidity is proportional to free volume. Chemical combination consequent on heat or pressure may qualify the law, which applies to suspensions as well. In suspensions a third cause of internal friction is the rotation of particles in the shearing process, energy being continually absorbed from the external stress in breaking down transient "structures." Hence flocculation increases yield value. Work is being continued on the structure effects in emulsoids. In many cases melting point is without scientific value. (*Ceram. Abs.*, **4**, 321 (1925).)

Bingham, Eugene C.

AN INVESTIGATION OF THE LAWS OF PLASTIC FLOW. U. S. Bur. Stand., *Bull.*, No. 13, p. 309 (1916–1917).—(1) The various types of viscous and plastic flow have been considered theoretically. According to the circumstances of the flow the viscosities and the fluidities may be additive or slipping or seepage may enter in to affect the character of the flow. The possible separation of the components of a mixture by means of flow has been considered. It has been shown that in a suspension of solid particles in a liquid there must be a dissipation of energy when the solid particles collide, as they must collide if the layers of the suspension move over each other. This dissipation of energy follows the laws of ordinary friction and not the laws of viscosity.

(2) Measurements have been made upon the flow of clay suspensions of different concentrations through capillaries of varying dimensions and at two temperatures.

(3) It is shown that plastic flow can be sharply differentiated from viscous flow by the "friction" necessary to start plastic flow. The friction is a linear function of the volume concentration. It is also affected by the presence of alkalis or acids, but it is independent of the length or diameter of the capillary as well as the temperature of the medium.

(4) For medium pressure the rate of efflux is given by the formula $v = K(P-f)$, where P is the pressure, f the friction, and K an arbitrary constant. The experiments indicate that at low pressures seepage takes place causing a perceptible change in the concentration, and that at high pressures there is a slipping which under certain circumstances may cause a sudden increase in the rate of flow.

(5) The fluidity becomes zero at the concentration of solid where the plastic flow begins, *i.e.*, where the friction begins to have a positive value. This concentration, where the particles are able to form a bridge across the capillary space, is reached long before the concentration corresponds to close packing of the solid particles. For very fine-grained material the range between the concentration giving zero fluidity and the concentration corresponding to close packing will be much greater than in coarse-grained material.

(6) The "mobility" of suspensions has been defined and calculated. The mobility decreases very rapidly from its maximum value in the concentration which has zero fluidity to a value not far from zero in the mixture which corresponds to close packing of the solid particles. The mobility increases with fluidity of the medium, but it is also greatly affected by the presence of alkalis or acids.

Bingham, Eugene C.

FLUIDITY AND PLASTICITY. (McGraw-Hill, 1922), pp. 215–40 and 319–23.

PLASTICITY. See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 42).

RELATION OF YIELD VALUE AND MOBILITY OF PAINTS TO THEIR SO-CALLED CONSISTENCY. See Booge, J. E. (this *Bibliography*, p. 32).

Bingham, E. C., Bruce, H. D., and Wolbach, M. O.

STUDY OF THE PLASTICITY OF PAINT. *Jour. Franklin Inst.*, **195**, 303 (1923).—(1) It appears that suspensions as well as the emulsoid type of colloids show the properties of plastic materials even at very low concentrations of the disperse phase. The viscosity, as ordinarily measured, is not a constant but a function of the shearing stress. (2) At high concentrations, the yield value concentration relation is linear; the material is truly plastic. (3) At lower concentrations, the yield value concentration relation is not linear; the material may be said to be pseudoplastic. (4) It seems to be possible to distinguish sharply between the plastic and the pseudoplastic condition. With lithopone suspended in linseed oil, the transition occurs in a mixture containing 14% of lithopone, by volume. This concentration may be related to important properties of the material, such as the fineness of structure, adhesion between the particles, etc. (5) The mobility-concentration (by weight) curve is linear, hence it seems possible by measuring the plasticity of a paint and of one other paint obtained from the first by thinning, to predict the plasticity of any paint made by thinning, provided that the plasticity correction is neglected for the pseudoplastic paints. (6) At 45.6% by volume of lithopone, the mobility would have a zero value. This concentration of zero mobility seems to be connected with the pore space of the material, and it may have considerable significance in determining the flow of dispersions.

Bingham, Eugene C., Bruce, H. D., Wolbach, M. O.

THE PLASTOMETER AS AN INSTRUMENT FOR PROCESS CONTROL. *Ind. Eng. Chem.*, **14**, 1014 (1922).—Amorphous materials often lack definite characteristics, melting point, solubility, and fluidity. The authors suggest the use of (1) the yield value, (2) the mobility, (3) the concentration of zero mobility, connected with the pore space, (4) the concentration of zero yield value, connected with particle size, and (5) the temperature at which the yield value becomes zero, analogous to the melting point. The authors also distinguish between plastic and pseudoplastic materials. (*Ceram. Abs.*, **2**, 50 (1923).)

Bingham, E. C., and Green, H.

PAINT A PLASTIC MATERIAL. *Proc. Amer. Soc. Testing Materials*, **19** [II], 640 (1919).—Fluids suffer permanent deformation under all shearing stresses, but plastic materials do not suffer permanent deformation until the shearing stress exceeds a certain amount which is the "yield value." Paint of painting consistency is proved to be a plastic material according to the above definition. Nine capillaries of different dimensions are used in the measurements. It is proved that flow is directly proportional to the pressure except for very small pressures, where seepage may be a disturbing factor. The pressure required to start the flow is a function of the dimensions of the capillary, but the authors postpone the evaluation of this function and the calculation of the true yield value until a later paper. It is possible, however, to obtain the true mobility of a plastic material at once. To be sure the apparent mobility depends upon the apparent yield value, but since the relationship between the two quantities is linear the true mobility is taken to be the apparent mobility extrapolated to the point where the yield value is zero. The mobilities (μ) and apparent yield values (f) of a series of ready mixed paints, measured with a single capillary, show that the mobility and yield value vary widely and quite independently of each other. Thus for a zinc oxide paint $\mu = 0.204$ and $f = 87$, for a zinc and lead paint $\mu = 0.373$ and $f = 320$, and for a C.W. lead paint $\mu = 0.174$ and $f = 117$. Paint pastes show a mobility as low as 0.000400 and paints as high as 0.750. The error measurement is claimed to be less than 1%; hence the differentiation of two plastic materials appears to offer little difficulty.

The authors have increased the accuracy of plasticity measurement and shortened the time required by following changes in the method described by Bingham.[1] Paints in flowing from a capillary form drops and it has been found that the weight of the drop is a linear function of the pressure producing the flow. Hence in a preliminary measurement the weight of a certain number of drops is determined at two different pressures after which the weight of a drop at any pressure can be calculated. The time of flow of a certain number of drops at as many different pressures as desired is then rapidly made and the weight of flow calculated. The serious error which is committed by attempting to measure the viscosity of a substance which is in reality a plastic material was brought out in the discussion of the paper by Thompson, Gardner, Ingalls, and others. A knowledge of both the yield value and mobility is necessary for an understanding of the properties of solids. (*Chem. Abs.*, **14**, 1048 (1920).)

Bingham, E. C., and Jacques, A. G.

SOME FACTORS WHICH AFFECT THE PLASTICITY OF PAINT. *Ind. Eng. Chem.*, **15**, 1033 (1923).—The effects on mobility and yield value of paints produced by long grinding, by changing the concentration of the pigment, by adding soaps, water, mineral oil, deflocculating agents, etc., are measured and tabulated. (*Chem. Abs.*, **17**, 3796 (1923).)

Bingham, E. C., and Murray, H. A.

A NEW COMBINED VISCOMETER AND PLASTOMETER. *Proc. Amer. Soc. Testing Materials*, **23** [II], 655 (1923).—The times required for liquids or soft solids to fill successive portions of a calibrated capillary are measured on a chronograph. As the shearing stress varies along the capillary, the necessary data for a plasticity determination, or for duplicating fluidity determinations are obtained in less time than is often required for a single fluidity determination. The method proves reliable when applied to castor oil over a range of temperatures. Preliminary measurements on a plastic paint give a lower yield value than was obtained with the Bingham and Green plastometer, but as the flow-shearing stress curve is linear, it is suggested that there may be more than one régime of plastic flow. The paper is criticized at length by Green. (*Ceram. Abs.*, **3**, 204 (1924).)

Binns, C. F.

GRINDING OF FLINT AND FELDSPAR. *Trans. Amer. Ceram. Soc.*, **5**, 281 (1903).—Study of a series of bodies, similar in composition, by which the comparative action of coarse and fine materials can be illustrated. The evidence produced was strongly in favor of fine grinding. The composition of the bodies studied consisted of kaolin, ball clay, flint, and feldspar.

Binns, C. F.

STANDARD FOR THE FINENESS OF GROUND MATERIALS. *Trans. Amer. Ceram. Soc.*, **8**, 244 (1906).—Description of an apparatus for elutriation and its use is given. This apparatus is a modification of the Schoene apparatus. The principle used is that of carrying a continuous stream of water from one vessel to another, the velocity being decreased by the increased diameter of each succeeding container.

Binns, C. F.

FUNCTION OF BORON IN THE GLAZE FORMULA. *Trans. Amer. Ceram. Soc.*, **10**, 158 (1908).—It is shown that the melting together of boric acid and silica at temperatures ranging from 1100 to 1200° is accompanied by an evolution of heat from which it is inferred that a boron silicate is formed. If this is so, the chemical function of B_2O_3

[1] U. S. Bur. Stand., *Bull.*, No. 278.

is similar to that of Al_2O_3 in a glaze. If B_2O_3 is taken as basic in borate glazes, the oxygen ratios of such glazes will not differ greatly from nonborate glazes, while according to the present practice of considering B_2O_3 acid, the oxygen ratio of borate glazes is markedly higher than for nonborate glazes. (*Chem. Abs.*, **2**, 3391 (1908).)

Binns, C. F.

SEGER'S RULES FOR CORRECTION OF GLAZE DEFECTS. *Trans. Amer. Ceram. Soc.*, **13**, 203 (1911).—BINNS held that feldspar in the clays must be considered and that the composition as shown by rational analysis (calculated from ultimate analysis) was essential. BURT placed much dependence upon fineness of grain. He criticized Purdy's methods and believed that his conclusions were too broad and sweeping. Burt's experience had shown much narrower range between craze and shiver than Purdy found. MADDOCK attributed all crazing to body defects and variations in firing. WEELANS was opposed to the use of 40% flint in an earthenware body. PURDY believed that change of the "china clay to ball clay" ratio would change the results. He attacked both the sulphuric acid digestion and the calculated rational analysis. (*Chem. Abs.*, **5**, 3893 (1911).)

Bippart, A.

RECESSED ENAMEL WORK. U. S. Pat. 665,166, Jan. 1, 1901.—In recessed enamel work, the combination of two frames having identical openings arranged to register with one another, one of the frames having the opening filled with enamel.

Bishop

MANUFACTURE OF ENAMEL. *Br. d'inv.*, **48**, 283; (*Rep. der Tech. Lit.*, p. 272 (1823–1853)).

Blackham

CRAZING IN ENAMELS ON CAST IRON. *Trans. Amer. Ceram. Soc.*, **14**, 545 (1912).—The casting from one of two flat-rimmed sink patterns crazed in the corner, at the rim. The difficulty was aggravated by making the pattern thinner but remedied by making it very heavy at this point. Lifting can usually be traced to the slush coat. Either the slush coat is defective, deficient, overheated, or applied too thin.

Blair, Frank M.

ENAMEL METAL SHINGLE. U. S. Pat. 1,572,377, Feb. 9, 1926.—A roof composed of a series of shingles, each with two longitudinal ribs and with a right angular downturned base flange extending below the body of the shingle and having therein two notches, one of the notches receiving the rib of a shingle to the right and the other receiving the rib of a shingle to the left, the shingle to the right and the shingle to the left being held in contact with one another by the engagement. (*Ceram. Abs.*, **5**, 117 (1926).)

Bleininger, A. V.

EFFECT OF ELECTROLYTES ON CLAY IN THE PLASTIC STATE. *8th Intern. Cong. App. Chem.*, **5**, 17(1912).—For (1) North Carolina kaolin, (2) Georgia kaolin, and (3) Tennessee ball clay, curves of water content-volume shrinkage were determined. Sodium, calcium, aluminum, and barium chlorides, and sodium sulphate in varying amounts were added to clays (2) and (3). Volume shrinkage was determined and shrinkage water and pore water calculated. With very low concentrations, volume shrinkage was increased but with further addition of the electrolyte it was greatly decreased (except with sodium sulphate which greatly increased shrinkage). At low concentrations, maximum

and minimum points on the volume shrinkage curve showed the ease with which equilibrium was disturbed. Expressed in terms of molar concentration, the activity of the reagents was in the order of their valences. (*Chem. Abs.*, **6**, 3170 (1912).)

Bleininger, A. V.

VISCOSITY OF CLAY SLIPS. *Trans. Amer. Ceram. Soc.*, **10**, 389(1908).—It might be said that clays are rocks which when pulverized and suspended in water produce a decided increase in viscosity.[1]

The efflux method, used by Simonis and by Mellor, is subject to irregularities and difficulties. B. employs the Coulomb method with a lead filled brass disk weighing 1333 g. suspended by a steel wire 3 to 5 meters long by 0.85 mm. diameter. The method obviously is not intended for clays which are coarse grained. The heaviest slip practicable consisted of 15% North Carolina kaolin. The precision was ±2%. The more dilute slips showed a negative viscosity. In terms of water as unity, the following are some of the results:

Per cent by weight	3	4	6	8	11	14	15
Tenn. ball clay No. 7 (at 19°)	0.98	1.00	1.05	1.20	2.20		
Florida kaolin (at 21°)	0.97	0.98	1.00	1.05	1.15	1.52	
N. C. kaolin (at 20°)	0.96	0.96	0.99	1.00	1.04	1.08	1.13

B. hopes that by viscosity measurements plastic clays may be correlated or classified. (*Chem. Abs.*, **3**, 107 (1909).)

Bleininger, A. V.

CERAMIC PROCESSES ASSOCIATED WITH COLLOID PHENOMENA. *Ind. Eng. Chem.*, **12**, 436 (1920).—The property of "plasticity is to be attributed to the dispersed state of the aluminum silicates, principally $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$, known under the general term of clay substance." Clay suspensions show the typical (1) turbidity of the filtrate, (2) Tyndall cone effect, (3) adsorption of basic ions. Separation of granular matter and the casting process are rendered easier by dispersion. Also coagulation is helpful in increasing plasticity and strength and in thickening of suspensions of glazes and enamels. Upon rewetting after drying, the original plasticity is not recovered at once, if at all, and the higher the temperature of drying the greater this difference. This is analogous to the action of a "set" gel. This change becomes irreversible at about 500° unless subjected to treatment with steam at high pressure. Firing shows two distinct periods in the early stage, (1) removal of hygroscopic water and (2) expulsion of combined water. After stage (1) and especially after stage (2) the clay is in a very sensitive state, absorbing gases readily and also acting catalytically. The dehydration is endothermic. Above about 900° an exothermic reaction takes place which may be associated with an irreversible change of colloidal nature or the dissociation of the aluminum silicate, perhaps into $Al_2O_3.SiO_2$ and SiO_2. (*Chem. Abs.*, **14**, 2063 (1920).)

Bleininger, A. V.

REPLACEMENT OF TIN OXIDE BY ANTIMONY OXIDE IN ENAMELS FOR CAST IRON. *Trans. Amer. Ceram. Soc.*, **14**, 754 (1912).—Discussion of paper by R. E. BROWN. The danger of poison with antimony could be avoided by using $Na_2Sb_2O_3$. (*Chem. Abs.*, **7**, 232 (1913).)

Bleininger, A. V., and Brown, G. H.

VISCOSITY OF CLAY SLIPS. *Trans. Amer. Ceram. Soc.*, **11**, 596 (1909).—The Stoermer viscosimeter was used. In this a falling weight causes a paddle to revolve in the

[1] *Sprechsaal*, p. 597 (1905).

liquid being tested, and the time for 100 revolutions is measured. The mechanical construction might be improved with respect to accuracy of fitting and greater elimination of friction. Ten clays were made into slips containing up to 25 to 55% clay. The viscosities were determined at various dilutions, and viscosity plotted as a function of per cent of clay. The curves are broken lines which roughly approximate straight lines. A fire clay shows the slowest increase of viscosity with concentration, then follows a group of four joint clays, a very plastic English china clay, and finally a group of four very plastic clays, sagger, ball, fire clay, and joint clay. "The viscosity of clay slips is a function of plasticity." (*Chem. Abs.*, **3**, 2737 (1909).)

Bleininger, A. V., and Clark, H. H.

VISCOSITY OF CLAY SLIPS DETERMINED BY THE CLARK APPARATUS. *Trans. Amer. Ceram. Soc.*, **12**, 383 (1910).—The Clark apparatus is not strictly a viscosimeter. It measures the force required to rotate a paddle at uniform velocity in whatever fluid is being tested. Upon the same shaft as the paddle is mounted a hollow metallic cylinder, height 0.5 inch, diameter 4 inches, thickness $^1/_{32}$ inch. Within the cylinder, but supported from above so that it has no mechanical connection with the cylinder, is an electromagnet arranged to revolve about the same axis as the cylinder. The magnet is revolved at constant speed by a motor, whose resistance is adjusted so that a reed frequency meter gives indication of the predetermined velocity. The magnet is supplied with storage battery current, and when so excited, the electrical forces set up in the cylinder cause it to rotate. The current supplied the electromagnet is adjusted so that it causes the cylinder to revolve at a definite fraction of the magnet's velocity, an optical device showing when this is exactly attained. The apparatus is calibrated so the torque in gram-cms. required to rotate the paddle is determined directly from the amperes supplied the electromagnet. Four clays were tested in slips containing 6 to 40% clay. The curves show a most unexpected break or maximum in every case, which is least pronounced in the case of Tenn. No. 3 ball clay and greatest for the English china clay. Practically the same thing occurred in experiments carried on with lime pastes, where breaks were very much more prominent for dolomitic than for high calcium limes. Ashley suggested in explanation that the colloid matter of clays and other substances exists in different sizes, of which the larger may be considered as polymerized. Each degree of association should have its own viscosity curve. But when dilution reaches such a stage that the polymerized molecules dissociate into an increased number of simpler molecules, if the dissociation occurs quickly enough, there will be an increase of molecules per unit volume, which is recognized source of increased viscosity. (*Chem. Abs.*, **5**, 176 (1911).)

Bleininger, A. V., and Fulton, C. E.

EFFECT OF ACIDS AND ALKALIS UPON CLAY IN THE PLASTIC STATE. *Trans. Amer. Ceram. Soc.*, **14**, 827 (1912).—Small additions of acids (HCl, H_2SO_4) to Georgia kaolin decreased volume shrinkage; alkalis (NaOH, Na_2CO_3) caused increases. If volume shrinkage changes are proportional to plasticity, as generally believed, these results disagree with Rohland's claims which were based on plasticity comparisons. (*Chem. Abs.*, **7**, 233 (1913).)

Bleininger, A. V., and Ross, D. W.

FLOW OF CLAY UNDER PRESSURE. *Trans. Amer. Ceram. Soc.*, **16**, 392 (1914).—A study was made of the relation between the flow of plastic clays through an orifice in a brass cylinder and the pressure exerted. The flowage behavior varied with the nature of the clay and with the per cent water. This method of study promises to be of great value in work upon the nature of plasticity. (*Chem. Abs.*, **8**, 3711 (1914).)

Bleininger, A. V., and Teetor, P.

THERMAL STUDY OF BORIC ACID-SILICA MIXTURES. *Trans. Amer. Ceram. Soc.*, **14**, 210 (1912).—Fused B_2O_3-SiO_2 mixtures are typical glasses with no definite deformation temperatures. There was no absorption or liberation of heat through the series B_2O_3–$B_2O_3{\cdot}3SiO_2$. With SiO_2 increasing from zero up to about $B_2O_3{\cdot}1.5SiO_2$, the amount dissolved by water is greater than the B_2O_3 content. At $B_2O_3{\cdot}2SiO_2$ there is a sudden and large decrease in solubility indicating the probable formation of a definite compound. (*Chem. Abs.*, **7**, 227 (1913).)

Bleissner, R.

PROCESS AND FURNACE FOR PREPARATION OF ENAMELS, GLAZES, FRITS, ETC. German Pat. 367,249, Sept. 22, 1921.—A mixture of the fine-grained constituents of the glaze, enamel, or frit, is passed continuously through a furnace where it is fused and the liquid mass is allowed to flow in an interrupted stream into water forming a water-seal to the discharge end of the furnace. The stream of burning gases which heat the furnace pass through it in the same direction as the charge and play around the issuing stream of molten material, so preventing solidification at the outlet of the furnace. (*Chem. and Ind.*, **42A**, 403 (1923).)

Blount, C. S.

TRANSPARENT CLOISONNÉ ENAMEL. British Pat. 7885, May 7, 1891.—Translucent cloisonné enamel or glass is made by fusing between strips of metal placed on a background of metal plaster or other suitable material, which is afterward removed, leaving the enamel fused together with the metal divisions in one piece, the separation of the background causing the product to be translucent. (*Chem. and Ind.*, **10**, 770 (1891).)

Blumenberg, H., Jr.

FLUX FOR ENAMEL, GLASS, ETC. U. S. Pat. 1,601,231, Sept. 28, 1926.—The use of a flux containing an alkali metal boron phosphate is specified. The boron compounds lower the temperature required for fusion. (*Chem. Abs.*, **20**, 3789 (1926).)

Blumenberg, H., Jr.

FLUX FOR ENAMEL COMPOSITIONS. U. S. Pat. 1,601,232, Sept. 28, 1926.—A flux for enamel, glass, or ceramic compounds containing alkali metal boron phosphate.

Blumenthal, Geo., Jr.

SOLUBILITY OF BORIC ACID FRITS. *Jour. Amer. Ceram. Soc.*, **3**, 152 (1920).—Nine different frits for whiteware glazes were used. Their composition was not known. The specimens were ground and sieved through 20- and 40-mesh sieves. The material used was that which had passed the 20-mesh but was retained on the 40-mesh sieve. Five grams were placed in a glass cylinder with 350 cc. distilled water. Blank runs were made with water alone. The glass cylinders were almost filled and placed on a shaking machine making about 17 revolutions per minute. The liquid and samples were agitated gently for 24 hours. No allowance was made for variations in the room temperature which could not be controlled, but which for a determination of this kind may be considered to be a negligible factor. After 3 or 4 hours the water showed a more or less pronounced degree of turbidity varying from a slight indication to a decided cloudy condition. This was evidently due to colloidal silicic acid which separated out. This colloidal silicic acid was determined as was the dissolved portion and these determinations checked by the loss in the undissolved frit.

RESULTS OF SOLUBILITY DETERMINATIONS

No.	Kind of frit	Appearance of frit	Colloidal silicic acid (%)	Portion of frit soluble in water (%)	Appearance of solution after shaking
1	Frit kiln	Glassy and clean	2.2	0.3	Clear, little silicic acid
2	Sagger	Not thoroughly melted	5.1	1.7	Quite cloudy
3	Frit kiln	Glassy and well fused	2.5	0.2	Cloudy
4	Sagger	Poorly fused	27.2	24.6	Very cloudy, frit slaked
5	Sagger	Slightly opaque, clean	2.2	1.9	Quite clear
6	Sagger	Glassy, undissolved flint	4.6	1.8	Cloudy
7	Sagger	Glassy and clean	2.2	1.1	Clear
8	Sagger	Well fused, hard, smoky	2.2	8.0	Clear
9	Frit kiln	Glassy, undissolved flint	2.2	0.5	Clear

(*Chem. Abs.*, **14**, 1743 (1920).)

Blumenthal, Geo., Jr.

NOTE ON THE HARDNESS OF GLAZES. *Jour. Amer. Ceram. Soc.*, **4**, 896 (1921).—(1) *Method of measurement:* The apparatus used consisted of a hardened tungsten-steel point which was allowed to bear on the glaze surface for 3 minutes under a pressure of 50 pounds. The hardness was then computed from the dimensions of the resulting indentation. Results were reproducible to about 5%. The presence of ridges and bubbles in the glaze was the principal cause of discordant readings. (2) *Results and conclusions:* The enamels show the lowest and the porcelain glazes the greatest hardness, while the whiteware glazes occupy an intermediate position. The difference in hardness between the enamels and the whiteware glazes is quite marked. There is also a rather well-defined difference between the whiteware and the porcelain glazes, but not a sharp separation between the lower- and the higher-fired porcelain glazes. Enough evidence has been accumulated to show that increased firing of the same glaze will increase the hardness. It appears also that increase in the alumina content brings about greater hardness.

Bock, B.

NOTE ON WHITE ANTIMONY ENAMELS. *Chem.-Ztg.*, **32**, 446 (1908).—Dangers are pointed out, owing to the ready solubility and the poisonous character of the compounds of antimony. Slow cooling of frits in place of the rapid quenching is advised. (*Chem. Abs.*, **2**, 2132 (1908); *Chem. and Ind.*, **27**, 566 (1908).)

Bock, B.

IMPORTANCE OF FLUORINE IN ENAMELS. *Chem.-Ztg.*, **32**, 730 (1908).—Fluorine lowers the melting point of the enamels decidedly but has no influence on the opacity of the resulting enamel. In all well-fused enamels practically no fluorine is found, it having been expelled by interaction with silica. (*Chem. Abs.*, **2**, 2718 (1908); *Chem. and Ind.*, **27**, 900 (1908).)

Bock, B.

FIXATION MATERIALS IN ENAMEL MAKING. *Chem.-Ztg.*, **33**, 109 (1909).—Fixation materials are those substances which have the effect of holding the fine enamel glass particles in suspension, thus preventing their settling to the bottom of the mass after fusion. These include clay, insoluble magnesium salts, soluble neutral salts, such as ammonium chloride (volatile), alkali carbonates and sulphates (partly volatile), and borax (nonvolatile). (*Chem. Abs.*, **3**, 1450 (1909).)

Boeck, P. A.

DETERMINATION OF THE EXPANSION COEFFICIENT OF SOLID BODIES. *Trans. Amer. Ceram. Soc.*, **14**, 470 (1912).—Inside a fused quartz tube is placed the specimen

in the form of a short tube, at either end of which there is a quartz tube. Both inner and outer tubes are fixed at one end, and the differential expansion due to the specimen is measured by a reading microscope. The whole is heated in an Ni-Cr wire furnace. Data are given for alundum, carborundum, ball clay, and fire clay. (*Chem. Abs.*, **7**, 230 (1913).)

Boeker, V. W.

INVESTIGATION ON ENAMEL CLAYS. *Jour. Amer. Ceram. Soc.*, **9**, 399 (1926).—Twelve representative enamel clays were examined for water of plasticity, drying shrinkage, modulus of rupture, and properties when fired to 1000°. The effect of any clay varies with the composition of the enamel. The suspension test alone is not a reliable measure of the ability of the clay to float the enamel in the dipping process. The character of impurities is fully as important as their quantity. A small per cent of carbonaceous material is not objectionable, unless it is in the form of coal or lignite. Finely divided $CaCO_3$ up to 0.5%, is not harmful; over 1.0% causes blister. Maturity and luster of enamels are inversely proportional to increasing porosity of the clays after firing at 1000°. Strength and ability to withstand thermal shock are influenced greatly by the kind of clay used. (*Ceram. Abs.*, **5**, 267 (1926); *Chem. Abs.*, **20**, 2734 (1926); *Chem. and Ind.*, **45B**, 917 (1926).)

Bogitch, B.

IRON-IRON SULPHIDE ALLOYS. *Compt. rend.*, **182**, 217 (1926).—Pure Fe-FeS mixtures, fused and protected from oxides by a layer of sodium silicate, do not form two liquid phases. Carbon causes separation of two layers, the upper of constant sulphur content, the lower containing an amount of sulphur dependent on the carbon content. An explanation of the desulphurizing of iron and steel is thus suggested. (*Ceram. Abs.*, **5**, 176 (1926).)

Bogue, R. H.

GELATIN AND GLUE. *Jour. Franklin Inst.*, **193**, 806 (1922).—The melting-point test was studied by many methods, and it was observed that the measurement of this property by plotting a viscosity-temperature curve, using a capillary pipette as a viscosimeter, and extrapolating to the temperature at which the rate of flow would be zero, corresponded well with other methods. It then became apparent that the extrapolation below 32 to 35°C was unnecessary, and that a viscosity measurement at that temperature resulted in an exactly similar differentiation. *Method for grading:* The final perfection of technic involved the use of the MacMichael viscosimeter, the viscosity in centipoises of an 18% solution dry basis at 35°C being noted. The conversion of MacMichael degrees to centipoises is easily done after a preliminary calibration against a liquid of known absolute viscosity, as castor oil, by a mere glance at a conversion curve. This being a straight line makes errors of observation improbable and a setting of the instrument may be made at which the readings indicate directly in absolute units.

Boissonnet

ENAMEL ON CULINARY UTENSILS. French Pat. 347,839, Dec. 24, 1905.—Process for the application on culinary utensils of ceramic enamels of all colors, transparent or opaque, and the fixing upon or under the enamels of a decoration of any color. The composition of a transparent enamel is given as: borax, 30 parts; boric acid, 20; silica, 5; porcelain enamel, 15; calcium carbonate, 30. (See *Chem. Abs.*, **1**, 130 (1907) for complete abstract.)

Boland, Albert J.

ENAMELING FURNACE. U. S. Pat. 1,290,060, Jan. 7, 1919.—In a muffle enameling furnace the vertical side flues are arranged in pairs with a longitudinal connecting flue at the top and an escape conduit extending through the furnace wall. The flues in each pair are provided with a left- and right-hand burner, respectively, below the level of the muffle floor; these burners direct the heating gases partly horizontally beneath and around the muffle, and partly vertically along its sides. (*Chem. and Ind.*, **38A**, 177 (1919).)

Bole, G. A.

MECHANISM OF PLASTICITY FROM COLLOID STANDPOINT. *Jour. Amer. Ceram. Soc.*, **5**, 469 (1922).—(1) *Introduction:* Brief statement of present conceptions of the colloid chemists. (2) *Theory:* Plasticity is caused by the enveloping film of colloidal material which surrounds the clay grains, this film being of opposite polarity to the grain proper. Addition of electrolyte acting as deflocculant causes the outer layer of film to be attracted to the ion of the same polarity as the clay particle, thus reducing the effective diameter and increasing the polarity of plasticity-inducing particles. Particles which were held by surface forces of "particles in contact" are no longer in contact and are actually repelling each other due to like and increased polarity. A flocculating ion drives action in opposite direction, causing an increase in depth of colloid film, thereby increasing the surface in actual contact and decreasing repulsive force of plasticity-inducing particles. Transport numbers as well as polarity are governing factors in ions of electrolytes. (3) *Measurements:* The touch method is proved to be unreliable. A unit of measurement is desirable. A plea for a unit of colloidality and standard method for measurement is given.

Bole, G. A., and Howe, R. M.

RÔLE OF CHLORIDES IN THE VOLATILIZATION OF FERRIC IRON (FROM ENAMELS). *Trans. Amer. Ceram. Soc.*, **17**, 125 (1915).—The removal of iron from the enamel mix during smelting through volatilization as the chloride is discussed. Efficiency factors (per cent iron divided by the per cent chlorine introduced as chloride) were determined as follows:

$BaCl_2$	00.00	LiCl	4.68
NaCl	3.76	$PbCl_2$	14.62
KCl	3.90	AgCl	14.00
$MgCl_2$	4.80	$SnCl_2$	18.47

The lower the melting point of the chloride the greater was its efficiency as a volatilizer of iron, $SnCl_2$ being the most active. (*Chem. Abs.*, **10**, 513 (1916); *Chem. and Ind.*, **36**, 879 (1917).)

Bolton, J. W.

CAUSE OF COMMON DEFECTS IN CASTINGS. I. *Foundry*, **55**, 357 (1927).—Blowholes and pinholes are always caused by gas, which may come from the iron, or from the sand, or may be entrapped during pouring of the castings. To eliminate blowholes, melting conditions must be correct; wet ladles must be avoided, the sand must not be too wet, and must have sufficient permeability to carry off the generated steam rapidly. (*Ceram. Abs.*, **6** [7], 265 (1927).)

Bolton, J. W.

CAUSES OF COMMON DEFECTS IN CASTINGS. II. *Foundry*, **55**, 403 (1927).—Discusses shrinkage cavities, scabs, washes, and cracking. (*Ceram. Abs.*, **6** [9], 373 (1927).)

Bonzel, C., and P.

CONTINUOUS FURNACE FOR FIRING ENAMELED WARE OUT OF CONTACT WITH FLAMES. French Pat. 392,285, July 13, 1908.—A number of conduits are placed transversely in a reverberatory furnace—projecting at each end for considerable distance. The flues through which the burnt gases from the furnace pass to the chimney are placed so as to heat the parts of the conduits outside but adjacent to the furnace. The goods to be fired travel through the conduits from end to end, the parts of the conduits outside of the furnace serving as preheating and annealing chambers. Alternatively, the separate conduits may widen out into one large muffle chamber in the center of the furnace. (*Chem. and Ind.*, **27**, 1204 (1908).)

Booge, J. E., Bingham, E. C., and Bruce, H. D.

RELATION OF YIELD VALUE AND MOBILITY OF PAINTS TO THEIR SO-CALLED CONSISTENCY. *Amer. Soc. Testing Materials*, June, 1922.—Fifty-two samples of thirteen commercial paints were examined in the plastometer designed by Bingham and Green, and the results compared with the average values awarded by a committee of seven paint experts acting as five independent observers, in an empirical notation of units of consistency, *i.e.*, "consistencies" on the thick side being represented by the units 1, 2, 3, etc., and on the thin side by –1, –2, –3, etc., the best painting consistency being designated by zero. The plastometer used differed from that described in the later papers of Bingham and his collaborators in the use of a simpler pressure stabilizer, and in the direct weighing of the material exuded from the capillary, in place of either the drop-counting method or the florometer reading. The accuracy of the plastometer in furnishing reproducible results is confirmed, and the nondependence of yield value on the dimensions of the capillary used is noted. Comparison of the average of the "consistency" values with the two factors of mobility (reciprocal of viscosity in dynes per cm.) and yield value (expressed in grams per sq. cm.) showed no simple relationship, but complete correlation was shown in the two sets of figures except in one case. The clearest and most simple relationship, however, was obtained by plotting the ratio of the quotient of mobility into yield value (f/μ) against consistency, when twelve out of the thirteen paints examined lay fairly close to a smooth curve, the exceptional case being represented by an enamel containing a vehicle with abnormally low fluidity. (*Chem. Abs.*, **16**, 4071 (1922).)

Booze, M. C., and Klein, A. A.

RAPID MEANS FOR THE DETERMINATION OF QUARTZ CONTENT OF FELDSPARS. *Jour. Amer. Ceram Soc.*, **6**, 698 (1923).—The quartz content is determined by making a rapid fusion of the feldspar without dissolving an appreciable amount of the quartz, crushing the fused mass, immersing a portion of it in a liquid of the proper index of refraction and comparing the visible quartz with standard samples containing known quantities of quartz. A difference of 5% quartz content can readily be detected. The fusion and optical examination can be made in two hours and does not require a knowledge of microscopy. (*Chem. and Ind.*, **42A**, 776 (1923).)

Bowman, James R.

CHANGES IN THE VISCOSITY OF CLAY SLIPS AND GLAZE SUSPENSIONS ON AGING AND BY TREATMENTS WITH ELECTROLYTES. *Jour. Amer. Ceram. Soc.*, **10**, 508 (1927).—The rate and extent of the spontaneous thinning out of clay slips and glaze suspensions were measured; the effects of electrolytes on the viscosities of slips and glazes after aging until minimum viscosity was reached were investigated; measurements of the rate and extent of the spontaneous thinning of a glaze after treatment with electrolytes were made, and further experiments bearing on spontaneous thinning were conducted,

such as heating the slip or glaze and the application of the colorimetric method in determining p_H, etc. (*Ceram. Abs.*, **6**, 350 (1927); *Chem. Abs.*, **21**, 3435 (1927).)

Bowman, O. O.

BONE ASH AS AN OPACIFIER FOR GLAZES. *Ceramist*, **1**, 218 (1921).—In substituting MgO for BaO it was found that MgO did not give any greater whiteness, but gave more fluidity and was more fusible. BaO deadened the opacity. With an increase of bone to 0.3, zinc may be increased to 0.4. With a decrease in bone to 0.2 the zinc may be increased to 0.4. Best glaze with 0.2 and 0.3 calcium oxide as bone ash:

$$\left.\begin{array}{l} 0.2\text{–}0.3\ CaO \\ 0.4\text{–}0.3\ K_2O \\ 0.4\text{–}0.4\ ZnO \end{array}\right\}\ 0.5\ Al_2O_3\text{–}3.5\ SiO_2$$

When calcium oxide as bone ash was 0.5:

$$\left.\begin{array}{l} 0.5\ CaO \\ 0.3\ K_2O \\ 0.2\ ZnO \end{array}\right\}\ 0.5\ Al_2O_3\text{–}3.5\ SiO_2$$

Boyd, R. C.

THE REFRACTORY VALUE OF ENAMELS. See *Ceramist* (this *Bibliography*, p. 63).

Brady, L. H.

FUEL OIL IN THE ENAMELING PLANT. *Enamelist*, **1** [1], 5 (1923).—Advantages of fuel oil are (1) small space required for storage, (2) ease of unloading, (3) labor saved by its use, (4) cleanliness, (5) better and easier temperature control, (6) oil furnace requires less floor space, and (7) oil furnace is cheaper to build and maintain. The function of the burner is to break up the oil as finely as possible and thoroughly mix it with air as quickly as possible. The question of air supply is important, particularly on a new installation. The higher the pressure, the greater the first cost of the equipment to provide it and the greater the cost of power and maintenance. On new installation a low pressure of from 4 to 10 oz. is recommended. It is possible with one burner, firing lengthwise of a 12-ft. enameling furnace, to carry a working temperature of 1700°F, with less than 15°F difference from end to end. Preheating of the air supply is advantageous.

Breck, George D.

TREATING FERROUS METAL TO PREVENT CORROSION. U. S. Pat. 1,580,647, April 13, 1926.—The process of producing noncorrodible metal elements which contains the steps of heating a slab or sheet of ferrous metal to a high temperature short of melting, covering the same with a superficial coating of a finely-divided metallic substance which consists largely of chromium, and immediately rolling the slab or sheet while it is still plastic to the desired shape and size whereby the metallic substance is incorporated with the ferrous metal. (*Ceram. Abs.*, **5**, 176 (1926).)

Bresl. Gwbl., p. 46(1871).

ENAMELING OF CAST IRON. (*Rept. der Tech. Lit.*, p. 405(1869–1873).)

Bridge, Laurence

FISHSCALING OF SHEET-IRON ENAMELS. *Ceram. Ind.*, **6**, 42 (1926).—Fishscaling is due to an underfired ground coat. B. advocates firing at lower temperatures for a longer time. For discussion see this *Bibliography*, p. 57.

Bridgman, P. W.

GENERAL MECHANICAL STRESS ON TEMPERATURE OF TRANSITION OF TWO PHASES (DISCUSSION OF PLASTICITY). *Phys. Rev.*, **7**, 215 (1916).—The question at issue was the effect on a transition (or melting) point of unknown extra stresses not hydrostatic in nature. A thermodynamic formula has been derived for the general case, and some special cases of it have been discussed. It was shown that if a liquid and solid are in equilibrium, and a change, density and pressure, supposedly equal on both phases, be applied, but if on account of some imperfection of the apparatus an additional stress not hydrostatic is applied to some portion of the surface of equilibrium, the melting or freezing would take place at the free surfaces with such changes of volume as would tend to produce throughout the mass just that change of hydrostatic pressure which was supposed to have been applied. In the case of two solids in equilibrium this redistribution of stress might not take place, on account of a protective coating of one solid over portions of the other. Objections are raised to the ordinary theory of plasticity on the grounds that plastic flow of a well-annealed metal begins at the same numerical value of stress whether in compression or tension, while the theory demands that the melting point be raised, and that there should, therefore, be no plastic flow at all under tension. B. modifies the theory so as to state that a solid subjected to any stress whatever experiences a depression of the melting point at the unstressed surface (or at a surface stressed by less than the average amount) and melting will take place at that surface if the stress is high enough. Thus, flow is produced by a condition of actual local melting followed by regulation with equalization of pressure on all the grains. This theory is then discussed. Values of the flow point calculated by Johnston are from 8 to 40 times too low, when compared with the experimental values of Faust and Tammann. (*Chem. Abs.*, **10**, 991 (1916).)

Brindley, L.

PRODUCTION OF TRANSFERS FOR EARTHENWARE, CHINA, GLASS, AND ENAMELED GOODS. British Pat. 15,442, Nov. 2, 1915.—The designs are printed on tissue paper in one or more colors by means of engraved copper plates or rollers in the customary manner. The tissue paper is then applied, with the printed surface innermost, to the gummed surface of a sheet of duplex paper. A softening medium such as a mixture of linseed oil and oil of turpentine is applied to the tissue paper, which is then removed, leaving a perfect print on the duplex paper ready for application to the article to be decorated. (*Chem. and Ind.*, **36**, 85 (1917).)

British Cast-Iron Research Association

CAST-IRON RESEARCH. See *Chem. and Ind.* (this *Bibliography*, p. 64).

Brooks, Howard L.

PREPARATION OF SHEET IRON FOR PICKLING. *Enamelist*, **3** [4], 9 (1926).—The use of cleaners to remove grease and oil from the metal is discussed.

Brooks, Howard L.

HEATING OF PORCELAIN ENAMELING FURNACES. *Enamelist*, **4** [3], 14 (1926).—The advantages of electric heat for enameling are quite apparent, but difficult to prove in dollars and cents. Losses are caused by the following conditions in a furnace: (1) a gassy furnace atmosphere, (2) uneven muffle temperature from back to front and side to side, (3) finely-divided particles and fragments of refractories blowing about in the firing chamber, due to sudden puffs of the oil burner, causing varying pressures outside of the muffle, (4) improper firing temperatures, due to varying oil pressure, caused

by inconstant viscosity of oil in line, or collection of sediment in oil line. A coal-fired furnace is even a greater menace for quality ware, owing to the variation in fuel and dust present in the coal itself.

Brooks, H. L.

PRICE VS. PROFITS IN THE JOBBING BUSINESS. *Enamelist*, **5** [2], 16 (1927).—Lower manufacturing costs, better equipment, and greater production have lowered the cost and increased the standard of enameled ware.

***Brooks, Howard L.**

DEVELOPMENT OF SHEET METAL FOR VITREOUS ENAMELING. See Aupperle, J. A. (this *Bibliography*, p. 11).

Brown, Geo. H.

EFFECT OF FINENESS OF GRAIN OF FLINT AND FELDSPAR. *Ceramist*, **4**, 29 (1924).—(1) The fineness of grain of commercial flints, prepared under the same condition, is somewhat dependent upon the nature of the raw materials from which they are produced. (2) Increased vitrification of a vitreous body may be secured by the use of more finely-ground flint. (3) Increased vitrification of a vitreous body may be secured by the use of more finely-ground feldspar. (4) Use of finely-ground flint and feldspar in a body is conducive to some of the increase in vitrification secured by wet grinding the flint and feldspar content of bodies in ball mills. (5) Substitution of a finely-ground flint for a coarser product permits the use of a higher total flint content in a body. (6) Difficulties from cracking or "dunting" of vitreous bodies may be lessened by the use of a more finely-ground flint or of a small proportion of extremely finely-ground flint.

***Brown, G. H.**

NOTE ON VISCOSITY OF CLAY SLIPS. See Bleininger, A. V. (this *Bibliography*, p. 26).

Brown, L.

ASPECTS OF BALL-MILL GRINDING. *Brick Clay Rec.*, **55**, 322 (1919).—A cylindrical ball mill 6 feet long, 5 feet in diameter and holding a batch of 4000 pounds is described. The important points in ball-mill grinding are as follows: (1) effects of time of grinding; (2) weight of flint pebbles and their wear; (3) measurement of water; (4) record of revolutions of the mill. Clay substance requires only enough grinding to mix it thoroughly with the coarse ingredients which must be well ground before the clay is added. By grinding the clay substance too much it is possible to destroy its working qualities. Indicators to record the number of revolutions are placed on the mills and with these the degree of fineness is kept constant. (*Chem. Abs.*, **14**, 457 (1920).)

Brown, R. E.

REPLACEMENT OF TIN OXIDE BY ANTIMONY OXIDE IN ENAMELS FOR CAST IRON. *Trans. Amer. Ceram. Soc.*, **14**, 740 (1912).—The effect of Sb_2O_3 is to increase the maturing temperature and to increase the whiteness and opacity when employed between the limits of 0.0 to 0.09 equivalent Sb_2O_3. If used between the limits of 0.1 to 0.14 equivalent, the enamels are dull at the lower limits, and matness increases at the higher. At the high limit, 0.14 equivalent, shivering is likely to occur. For brilliant enamels of good opacity and texture, the limits are 0.06 to 0.09 equivalent, about 0.075 being preferable. Bluish and greenish casts were not present to an aggravated extent. The most likely enamel, taking all points into consideration, was:

0.16 K_2O 0.05 ZnO 0.10 CaO 0.15 PbO 0.54 Na_2O	0.16 Al_2O_3 0.20 B_2O_3	1.80 SiO_2 0.075 Sb_2O_3

Composition of ground coat was:

0.30 K_2O 0.24 Na_2O 0.159 CaO 0.219 MgO 0.081 PbO	0.297 Al_2O_3 0.31 B_2O_3	2.19 SiO_2

(*Chem. Abs.*, **7**, 232 (1913); *Chem. and Ind.*, **31**, 1129 (1912).)

Brown, William Norman

REFERENCE BOOKS ON ENAMELS. See *Jour. Amer. Ceram. Soc.* (this *Bibliography*, p. 166).

***Bruce, H. D.**

STUDY OF THE PLASTICITY OF PAINT. See Bingham, E. C. (this *Bibliography*, p. 23).

THE PLASTOMETER AS AN INSTRUMENT FOR PROCESS CONTROL. See Bingham, E. C. (this *Bibliography*, p. 23).

RELATION OF YIELD VALUE AND MOBILITY OF PAINTS TO THEIR SO-CALLED CONSISTENCY. See Booge, J. E. (this *Bibliography*, p. 32).

Brunner, Alfred

CORROSION RELATIONS AT DIFFERENT TEMPERATURES OF IRON AND STEEL ALLOYS KNOWN UP TO THE PRESENT AS NONRUSTING. *Vierteljahresschr. naturforsch. Ges. Zürich*, 69.—A study of the action of chemical reagents on various types of steel at room temperature, at 60 to 80°, and at 400°. The most important fact determined was that the greatest resistance to corrosion is possessed by highly alloyed steels containing four components. Furthermore, chromium steels with at least 11% chromium and a low carbon content (below 0.2%) are practically as resistant. With increase in the per cent chromium or with the introduction of nickel the resistance increases still more. In contrast to the chromium steels, pure nickel steels are easily attacked. Spring water, sulphur dioxide, dilute nitric acid, and organic acids such as acetic, malic, citric, and lactic acids attack nickel steels more readily than chromium steels. Krupp V2A steel was the only one found which was resistant to organic acids and to sulphur dioxide. Nickel steels are more resistant to sulphuric acid. No definite relations could be determined, for the individual types of steels showed great variations which could not be correlated with their composition. At boiling temperature they often are easily corroded if air is brought in contact with the surface simultaneously with treatment with salt or acid solutions. Contact experiments involving Cr-Fe and Cr-Ni-Fe alloys in salt solutions with ordinary steels showed that the former are resistant to corrosion at the expense of the latter. For proof against rusting it is important that there be heat treatment before or after working. Small variations may greatly impair the resistance to rusting, and polishing is of importance. The resistance to rusting decreases when the alloy becomes tarnished. Technical applications of nonrusting steels and highly alloyed silicon-castings included machines and equipment which are exposed to high temperatures and where there is no possibility of condensation on the polished surface. If the latter is the case, then such alloys can be exposed even to strongly acid vapors. If they

condense on the surface, however, only Krupp V2A steel is suitable. With the exception of V2A steel, it is important whether constant or periodic exposure to chemicals is involved. (*Ceram. Abs.*, **5**, 13 (1926).)

Buck, Eugene Charles

VITREOUS COMPOSITIONS AND ARTICLES MADE THEREFROM. U. S. Pat. 1,570,202, Jan. 19, 1926.—An improved vitreous composition comprising a fused complex metaphosphate of aluminum and an alkali earth metal substantially free from silica. (*Ceram. Abs.*, **5**, 81 (1926).)

***Buckeye Porcelain Enamel Plant**

GIVE EQUIPMENT LONGER LIFE. See *Ceram. Ind.* (this *Bibliography*, p. 60).

Buckingham, E.

PLASTIC FLOW THROUGH CAPILLARY TUBES. *Proc. A.S.T.M.*, **21**, 1154 (1921).—As the formula of Bingham and Green is only a very rough approximation, B. mathematically develops the more exact formula for a steady flow through a long, round tube and for the volume rate of discharge. The effect on the volume rate of discharge formula due to the introduction of Green's hypothesis of viscous slip is also given, together with a graph of the discharge curve. To reduce the importance of slip it is necessary to use large tubes. (*Ceram. Abs.*, **1**, 64 (1922).)

Buckley, H., and Grieveson, C. J. W.

PORCELAIN-ENAMELED STEEL REFLECTORS. *Illuminating Research Tech. Paper*, No. 3 (1926).—The artificial lighting of industrial processes demands a fitting which, in addition to providing adequate illumination for the work in hand, is reasonably permanent, moderate in cost, and easy to keep clean. Porcelain-enameled steel reflectors fulfill these requirements fairly well, and, in various shapes, have come into extensive use for industrial lighting. The type of reflector known as the Industrial Reflector Fitting (No. 1, British Engineering Standards Assn.) aims at combining the good qualities of the flat cone and of the deep bowl, avoiding the pronounced glare of the one and the patchy illumination of the other. (*Ceram. Abs.*, **6**, 200 (1927).)

***Buckwalter Stove Co.**

RIGID CUPOLA, SAND-BLAST REGULATION FACTORS FOR GOOD ENAMELING. See *Ceram. Ind.* (this *Bibliography*, p. 57).

Builder, **62**, 29; (*Rept. der. Tech. Lit.*, p. 185(1891–1893)).

HISTORY OF ENAMELING.

Bull. Amer. Ceram. Soc., **1** [8], 161 (1922).

DISCUSSION[1] ON "MICROSCOPIC STUDY OF GROUND-COAT AND COVER-COAT ENAMEL REACTIONS."—R. R. DANIELSON: In the study of grayware enamels it has been noted that those enamels which show blistering from an excess of salts in the dipping operation do not usually develop fishscaling, although normally they scale. Enamels which are under great compression because of their low coefficient of expansion as compared with that for steel will shiver and flake off in large patches when overfired, although when properly fired they develop only typical small scales. The shivering, which Mr. Geisinger describes, is an exaggerated development of the fishscale which occurs in the

[1] E. E. Geisinger, *Jour. Amer. Ceram. Soc.*, **5** [6], 322 (1922). See this *Bibliography*, p. 128.

form of the typical scale when the enamels are properly fired. Another factor which may have caused shivering in G.'s work is the steel which for his purpose is of comparatively heavy gage, thus tending to place the enamel under still greater compression. E. P. POSTE: My observations check the statements of G. in regard to the general nature of the firing of enamel. It is probable that with the average steel enamel no one point in the firing involves the entire absence of unfused material and bubbles, so that the best compromise which may be adopted as a normal firing involves the presence of small amounts of unfused material and also the presence of relatively small amounts of fine bubbles. The study of chips of enamel in cross-section is a fruitful field, not only as a matter of determining the conditions existing in the enamel but the possible causes of lack of adhesion of the enamel to the metal.

Bull. Amer. Ceram. Soc.,[1] **1** [10], 235 (1922).

DISCUSSION ON "A MODIFICATION OF THE MOLECULAR FORMULA FOR GLAZE AND ENAMEL CALCULATIONS."—H. F. STALEY prefers to use calculated melted weights instead of the molecular formula. R. R. DANIELSON: Fluorides are the only materials that have been definitely placed in suggested formula. With some formula, it would still be impossible to figure definitely just how many of the various constituents, potash, soda, etc., are derived from the various batch materials unless the exact chemical analysis of each is known. J. E. HANSEN: The composition of feldspar must be known. The old formula admits of greater misinterpretation of the fluorides and this modification certainly does establish the identity of the fluorides and seems to present certain advantages which are worthy of being taken into consideration. R. D. LANDRUM: Batch mixture should always be given. This combined with the old molecular formula tells a whole lot. Suggests using a factor which represents the number of molecules, obtained by dividing the molecular weight into pounds. J. E. HANSEN: With some systems it would be necessary to keep in mind two tables when interpreting the formula. It is a case of drawing the line between the utmost simplicity and a certain amount of complexity.

Bull. Amer. Ceram. Soc., **1** [11], 305 (1922).

DISCUSSION[2] ON "WET-PROCESS ENAMELS FOR CAST IRON."—J. E. HANSEN: Some of the conclusions reached are true only on enamels of the particular type under discussion and may not apply to all types; *e.g.*, the limit as given for sodium oxide in a sintered ground coat may safely be exceeded in a ground coat of the melted type. It is known that certain types of a melted ground coat, with suitable mill additions, are successful and may give even greater strength and adherence than those of the sintered type. The fusion point of ground coats and cover enamels should bear a close relation to each other and if the composition is correct, the cover enamel can be fired at the same temperature or even a slightly higher temperature than the ground coat. Many cases of pinholing in cover enamels can be traced to the lack of such a close relationship in the fusion points of the respective coats and to overfiring of the cover enamel. The crawling of high boric oxide enamels is not due to the higher viscosity imparted by an excessive amount of that oxide, but rather to the dissolved salts of boric acid which, crystallized from the aqueous suspension of the frit, give up their water of crystallization as the enamel is fired, and by their swelling cause crawling. The crawling of enamels high in cryolite may possibly be explained by the high viscosity and high surface tension of

[1] J. E. Hansen, *Jour. Amer. Ceram. Soc.*, **5** [6], 338 (1922). See this *Bibliography*, p. 144.

[2] R. R. Danielson and H. P. Reinecker, *Jour. Amer. Ceram. Soc.*, **5** [10], 647 (1922). See this *Bibliography*, p. 87.

enamels rich in aluminum compounds. The same effect can be developed in an enamel to which a large amount of aluminum oxide or hydrate is added. W. C. LINDEMANN: In checking the work of Danielson, all enamels for both ground and cover coats that seemed practicable were tried out on a commercial basis. The results in general checked the results shown in the laboratory. The ground coats that gave the best results were as follows in the order named: Rg7, Rg1, and Rg26. Ground coats Rg17, 25, and 18 as mentioned by Mr. Danielson were not practicable on continuous use, causing various defects in the final enamel which could not be overcome. On the other hand, Rg7, which seemed to give uniformly good results on all trials, is not mentioned. Regarding the cover coat, the results show that R1 seemed to be the best for general purposes with R14 and R11 as reasonably good enamels. R28 and R18 as mentioned, however, did not give satisfactory results, R28 not having sufficient covering capacity and R18 the same. Both R28 and R18 if covered heavily, would cause crawling to such an extent that the pieces would be unusable. The ground and cover coats given seem to work reasonably well together using any one of the ground coats with any one of the cover coats, but the best combination seemed to be, as a final checkup, the use of Rg7 as a ground coat with R1 as a finish coat. Precaution was necessary, however, on the use of these enamels since the Rg7 was rather sensitive on firing and if overfired caused cracking in the finish enamel, and when underfired, caused blistering. If this ground coat was fired properly, good results could be uniformly expected. In addition, when using Rg7 as a ground coat, there were fewer black spots appearing in the white or finish coat than on any other enamel tried in the entire series. This is an important item since there are very few enamels in wet cast-iron work when using a white finish coat where black spots are not noticeable. M. E. MANSON: The degree of smelting the ground coat is of great importance. There is one formula, which when mixed raw in a mill, gave very good results. When sintered and ground and covered with the same cover coat, it blistered badly. With the particular ground coat which was the basis of most of our experiments, it was found that the addition of 15 to 20% of clay in the mill gave best results. The greatest trouble with this series was blistering of the cover coat. By adding 20% of clay in the mill, and softening the frit accordingly, it did away with the blisters, but the cover enamel was still full of what Danielson calls "incipient pinholes." They look like skin pores, and are present in nearly every piece of wet enameled cast iron. The further modification of this formula by reducing lead oxide from 8 to 3% and raising borax proportionately gave a successful wet enamel. Test pieces made from this were uniformly good, with very few pores. A one-hundred-pound batch, used on regular factory pieces was fairly successful, but required very careful firing. This substitution of borax for lead oxide had exactly the opposite effect from that observed by Mr. Danielson. There are many factors affecting a wet enamel besides the enamel composition, such as (*a*) a ground coat giving good results at 1500° will be a failure at 1700°, (*b*) composition of the iron, and (*c*) thickness of ground coat. R. R. DANIELSON:[1] The majority of the ground coats can be fired to a semiglassy finish. The sintering method, however, results in ground coats possessing more satisfactory adherence to the castings. Almost invariably adherence has been improved by the undersmelting of the ground coat. Enamels high in boric oxide are very viscous even in the smelting, and the crawling of these enamels must be due to this rather than to dissolved salts of boric acid. While the soluble salts may tend to cause cracking in extreme cases, it does not seem that this action alone would cause crawling on enamels fired as slowly as the enamels applied on castings. R. R. DANIELSON:[2] The various factors aside from enamel composition have an important bearing on the results to be obtained with enamels of

[1] Reply to J. E. Hanson.

[2] Reply to M. E. Manson.

the wet-process type, but the same conditions are encountered in practically any type of enameling. A temperature of 1700°F might not be practicable for wet-process enameling on cast iron, for there would be a tendency for the surface of the enamel to gloss over in the early stages of the firing, tending to entrap gases held in the castings, with blistering of the enamel as a result. Certain dry-process enamels do give good results when used by the wet process, but that is not true in all cases and unsatisfactory results can be expected with certain other types. R. R. DANIELSON:[1] Enamel compositions developed in this as well as other investigations have given satisfactory results in some plants, while in others the reverse has been true, due undoubtedly to variations in technic encountered in the several plants. Rg7 was not included in the list of the more promising compositions because of its comparatively short firing range. Evidently the operator is skilful enough to use it successfully. R28 and R18 are covers, more particularly adapted to those factory conditions. They are not uncommon and make it desirable to use a cover that will cover satisfactorily in all cases even though it is necessary to apply several coats in order to attain sufficient opacity.

Bull. Amer. Ceram. Soc., **1** [12], 360 (1922).

DISCUSSION[2] ON "THE EFFECT OF SOURCES OF PIG IRON UPON THE ENAMELING OF CAST IRON."—E. P. POSTE: With particular reference to the subject of cast iron as a material to be enameled, there are two phases of the matter which should receive consideration; *i.e.*, the composition and structure of the iron. Range of compositions recommended by a large number of enamelers for sanitary ware:

Sulphur	0.07–0.09	Silicon	2.20–3.00
Phosphorus	0.70–0.80	C. carbon	0.20–0.40
Manganese	0.30–0.60	G. carbon	3.00–3.30

COMPOSITION OF VARIOUS EUROPEAN IRONS (after enameling)

Sulphur	0.05–0.10	Silicon	1.70–2.70
Phosphorus	0.90–1.80	C. carbon	0.09–0.20
Manganese	0.30–0.70	G. carbon	2.90–3.65

Slight differences in combined carbon really mean quite radical differences in structural composition. As a specific case 0.10 and 0.30% combined carbon are compared. In the former case there is 1.50% cementite and 11.1% pearlite; in the latter 4.5% cementite and 33.3% pearlite. The whole matter of the form of the graphite plates, penetration of gases, permanent growth of iron on heating and several related subjects cannot be overlooked in a thorough study of the problem. HOMER F. STALEY: Quotes from pp. 246 to 248 of Metallurgy of Cast Iron by Thos. D. West, 13th ed. West found that the composition of carbon 3.00 to 3.75, phosphorus 0.80 to 1.00, manganese 0.40 to 0.60, silicon 2.50 to 3.00, sulphur to be below 0.07; was quite satisfactory with the exception that the silicon content should vary from 1.50 to 2.50. This emphasizes the possibility, recognized by Mr. Manson, that the trouble may be due to separation of carbon in irons with low combined carbon.

Bull. Amer. Ceram. Soc., **2** [6], 163 (1923):

PROPOSED TENTATIVE FELDSPAR SPECIFICATIONS.

Bull. Amer. Ceram. Soc., **2** [6], 166 (1923).

PROPOSED TENTATIVE SPECIFICATIONS COVERING PURCHASE OF PULVERIZED FLINT.

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[1] Reply to W. C. Lindemann.

[2] M. E. Manson, *Jour. Amer. Ceram. Soc.*, **5** [11], 806 (1922). See this *Bibliography*, p. 206.

Bull. Amer. Ceram. Soc., **2** [6], 170 (1923).

RECOMMENDED SPECIFICATIONS FOR LIMESTONE, QUICKLIME, AND HYDRATED LIME.—Complete directions for sampling, testing, and retesting are given.

Bull. Amer. Ceram. Soc., **2** [6], 173 (1923).

SPECIFICATIONS FOR CERAMIC WHITING.—Definition, use, and requirements of whiting together with directions for sampling and testing are given.

Bull. Amer. Ceram. Soc., **2** [9], 300 (1923).

DISCUSSION ON "TRANSPARENT ENAMELS."—T. A. WRY: It would be interesting to obtain a highly-polished steel surface and have on that surface an enamel that will not impair the reflecting-power of the surface and will withstand weathering conditions. R. R. DANIELSON: During the War the Government was interested in a large reflector that would not be affected if hit by a bullet. We attempted to enamel silver at that time and tried without success to get the same results as were obtained by forming a polished silver surface. The coating of glass on the silver surface cut down the brilliancy; the experiment seems impractical. R. D. LANDRUM: It is said that in Europe there is such an enamel on steel. We all have obtained certain glazes that would adhere to the steel and show the steel through. H. F. STALEY: In order to have the enamel adhere to the steel a ground coat must be used which tends to dissolve the surface with more or less corrosion whereas in order to get a mirrorlike effect a highly polished surface is needed. In other materials, for instance, in gold, that is done. The material shows through the enamel. Perhaps Mr. Wry could solve the problem by trying some other material. All transparent enamels on steel which we have attempted to fire have turned more or less black.

Bull. Amer. Ceram. Soc., **2** [9], 302 (1923).

DISCUSSION[1] ON "ZIRCONIA IN ENAMELS."—Substitution of zirconium oxide for tin oxide increased fusibility. (Increased refractoriness.) Greater resistance to acid was noted when zirconium oxide was added as a batch addition. Points of procedure and methods of some of the tests are also taken up. The above points were brought out in a general discussion by the following men: W. F. Wenning, H. C. Arnold, E. P. Poste, W. J. Vollrath, H. F. Staley, F. R. Glenner, B. A. Rice, F. J. Jaeger, J. A. Aupperle, M. E. Manson, R. R. Danielson, L. J. Munroe, and R. D. Landrum.

Bull. Amer. Ceram. Soc., **2** [12], 370 (1923).

DISCUSSION[2] ON "SANDBLAST CASTINGS TO BE ENAMELED."—Steel grit, crushed steel, and shot have been used in place of sand with good results. Sandblast requires about 60 horsepower in all and costs about $2500. Sandblasting is superior to pickle. The discards on the pickle have dropped as much as 20 to 30%.

Bull. Amer. Ceram. Soc., **3** [6], 224 (1924).

DISCUSSION[3] ON "EXACT NOTIONS OF FLUORINE ENAMELS."—CHARLES MUSIOL: Musiol uses some of Hansen's data to show by subtractive analysis that in one case there was a complete disappearance of fluorine and loss of SiO_2, and in the second case complete disappearance of fluorine, loss of SiO_2, and a feeble loss of Na_2O and B_2O_3.

[1] W. F. Wenning, *Bull. Amer. Ceram. Soc.*, **2** [5], 102 (1923).

[2] F. G. Jaeger, *Jour. Amer. Ceram. Soc.*, **6** [9], 976 (1923).

[3] C. Musiol, *ibid.*, **7** [2], 105 (1924); above is reply to J. E. Hansen.

The oxygen to form CaO of CaF_2 is available from water which would be present in the enamel batch as humidity hydrated water or water of crystallization. Whether the fluorine disappears under the form of SiF_4 or under any other form constitutes an academic question which may be of some curiosity to the chemist, but which is not useful at all for the enamelist. The vital question for the latter is to know whether or not the partial disappearance of the fluorine always involves a decrease of SiO_2, as certain chemists pretend. H. H. STEPHENSON believes it improbable that the element fluorine escapes. SiF_4 and BF_3, formed directly or catalytically, are the leading probabilities of fluorine escaping. S. says that a well-equipped spectographer would settle the matter in a few minutes. J. E. HANSEN: The possibilities for various chemical combinations to be formed in the melting of an enamel batch are so numerous, and are subject to such complexities, that even with a combination of chemical and mathematical relationships there can be no real proof until it is substantiated with chemical data showing the quantity and composition of the gas evolved during the melting process.

Bull. Amer. Ceram. Soc., **3** [10], 375 (1924).

DISCUSSION ON PLASTICITY.—E. C. BINGHAM: Yield value and mobility are independent variables, which together make up plasticity. If the mobility concentration curve is linear, it is only necessary to know the fluidity of the oil and the mobility of one concentration of paint in order to calculate the mobility of any mixture. The concentration of zero mobility can also be calculated where close packing takes place. It is apparent that beyond the concentration of zero mobility any shear must be of a different character, since there is no longer sufficient dispersion means to fill the pore spaces. The yield value also increases with the concentration and this increase, over a considerable range, appears to be a linear function of the concentration. The concentration of zero yield value is where there is the transition from viscous liquid to plastic solid. The point of zero yield value is probably dependent on the size of the particle. This concentration is of importance as an indication of the adhesion between the pigment and the oil or between the particles of the disperse phase. The yield value-concentration curve is not linear at low concentrations. Below the concentration of zero yield value the flow may be spoken of as pseudoplastic. E. C. BINGHAM:[1] The fact that the enamel becomes stiff on adding magnesium salts indicates that there is a large increase in yield value. It is quite possible that the mobility is changed but little. E. C. BINGHAM:[2] In the investigation of paints an effort was made to establish some relation between yield value and mobility. As stated, it was found that, in general, the yield value fluctuated within a very narrow range. If in enamels the yield value must also have a certain value either by the use of flocculating agents or otherwise the solution of the problem will be simpler than that suggested by Mr. Poste. If on the other hand the yield value and mobility are both to be specified it is quite possible to specify the arbitrary limits for each one. The yield value is the important thing in enamels as in paint, because it is necessary to hold the enamel on the ware. H. F. STALEY: The yield value is the deciding factor and the mobility may go up or down as it may, but it has no effect on the dipping qualities of the enamel. E. C. BINGHAM:[3] The specific gravity might be used in conjunction with the plasticity curves in fixing the yield value and mobility. Other factors must be the same in order to do this. W. C. LINDEMANN: Japanners use the hydrometer to bring their japan to the same reading that they have used before. H. F. STALEY: Hydrometer readings in connection with the work on enamel slips has not proved satisfactory. B. T. SWEELY: It is the flocculation of the

[1] Reply to B. T. Sweely.

[2] Reply to E. P. Poste.

[3] Reply to W. C. Lindemann.

clay that interferes with the use of specific gravity. E. C. BINGHAM:[1] Mr. Cooke has obtained very good results with his simple apparatus. No effort has been made to adapt the instrument used at Lafayette College to plant use. This method was to measure the time required to fill different portions of a long capillary tube under a constant pressure. Fineness of grinding as well as flocculation have a very great effect on plasticity. H. F. STALEY: With any diagram or standard such as Mr. Poste has suggested, the fineness of grinding should be specified as well as the concentration. W. S. TYLER: An important factor in the matter is to find some way to stabilize enamels in the slushing pan. If the matter of grinding were given serious consideration in its relation to the fineness of the enamel this question could be solved. An enamel changes as soon as it is put into the slushing box and there are no two hours in the day when it is absolutely the same, unless it is being worked all of the time.

Bull. Amer. Ceram. Soc., **3** [11], 437 (1924).

DISCUSSION[2] ON "EFFECT OF MUFFLE ATMOSPHERE ON FIRING ENAMELS."—General discussion on different points involved in this work by Vollrath, Cooke, Schwier, Hansen, Landrum, Sweely, Poste, Lindemann, Bardush, Staley, Jaeger, Manson, Korman, and Anderson. Main points in discussion: (1) Plenty of oxygen should be available. Cooke found that six cubic inches of air to one square inch of enamel surface was the lowest point in air capacity. Poste found that for oil burners 7% oxygen in the furnace atmosphere was satisfactory. Landrum suggested the possibility of introducing air along with the ware. (2) Bardush eliminated ground-coat blistering by treating the coal with calcium chloride before firing into the gas producer. Instead of yellowish gas, bluish gas was obtained. (3) Jaeger obtained good results from a shallow furnace (spring of the arch of the furnace being eighteen inches from bottom); no evidence of insufficient air after six months' operation. (4) Cooke stated that if blistering was caused by the evolution of a gas either from the surface of the steel or from the enamel, it did not escape into the surrounding air in any sufficient quantity to be detected by analysis. (5) Cooke also said that the film of iron oxide is absolutely essential. Taking into account the quantity of this film in proportion to the weight of the enamel the percentage is rather high. It is to be doubted if the same effect could be gained by adding that much raw oxide to the enamel without disrupting the formula.

Bull. Amer. Ceram. Soc., **4** [2], 73 (1925).

ENAMEL DIVISION COÖPERATIVE RESEARCH.—A thorough investigation of the relations between the composition and structure of cast irons and their enameling properties is to be undertaken by the U. S. Bureau of Standards. A tentative outline of the work to be done is given.

Bull. Amer. Ceram. Soc., **4** [4], 191 (1925).

REPORT OF COMMITTEE ON ENAMELING FURNACES FOR WET-PROCESS CAST-IRON ENAMELS.—Data received from twelve questionnaires, covering fourteen different furnaces, was tabulated and discussed.

Bull. Amer. Ceram. Soc., **4**, 193 (1925).

REPORT OF DIVISION COMMITTEE ON STANDARDS, 1924–25.—Brief review of work that had been done during the year. The work was divided into three classes: (1) enamel raw materials, (2) flotation of enamels, and (3) opacity of enamels.

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[1] Reply to H. D. Cushman.

[2] R. D. Cooke, *Jour. Amer. Ceram. Soc.*, **7** [4], 277 (1924). See this *Bibliography*, p. 74.

Bull. Amer. Ceram. Soc., **4** [4], 198 (1925).

CAST IRON FOR ENAMELING PURPOSES.—Bureau of Standards Notes: Outline of the work which had been done by the Bureau to date, also outline of further work to be done on the subject. No conclusions had been drawn at this point because the investigation was not far enough advanced.

Bull. Amer. Ceram. Soc., **4** [5], 226 (1925).

DISCUSSION[1] ON "PLASTIC PROPERTIES OF ENAMEL SLIP."—Discussion of the above subject by R. D. Cooke, H. F. Staley, R. R. Danielson, R. D. Landrum, and B. T. Sweely. Main points of the discussion are as follows: Mobility increases in a linear manner with the solid content and has a concentration of zero mobility. At the concentration of zero yield point the mixture passes from a liquid to a solid. These methods should give valuable results in determining the suitable clays for enameling purposes with reference to their ability to suspend the enamel and provide good operating consistency. This control gives another method of making a standard for shop practice. It will be a means of controlling the amount of enamel that is put on ware, and by making the slip always work the same, a method of keeping the procedure uniform can be found.

Bull. Amer. Ceram. Soc., **4** [7], 330 (1925).

SECOND PROGRESS REPORT ON CAST IRON FOR ENAMELING.—Bureau of Standards: The three main possibilities as to the cause of blistering are: (1) Some gas is taken up as such in the blast furnace. (2) Some element not shown by ordinary analysis might be present in the pig and in a hidden way be responsible for the trouble. (3) Presence of graphite on the surface.

Bull. Amer. Ceram. Soc., **6** [9], 259 (1927).

REPORT OF ENAMEL DIVISION COMMITTEE ON STANDARDS, 1926–27.—Under flotation of enamels the Bureau of Standards has conducted an investigation on "Controlling the Consistency of Enamel Slips." A reflection gage used in determining the quality of enameled reflectors is suggested for investigation of its utility. It was thought inadvisable to compile a set of methods of analysis for enamel raw materials. Further circularization has been carried on in an effort to increase the usefulness of the questionnaire on control tests. Additional problems suggested are: (1) definitions of terms used in the enameling industry, (2) methods of expressing enamel compositions, and (3) terminology for expressing the degree of action of acids on enamel surfaces. Recommended tentative methods for deformation temperature of enamel and for fineness of wet-milled enamel are given in detail. (APPENDIX A): In order to determine the accuracy of the cone deformation temperature test as applied to enamels, a considerable quantity of frit was prepared at a central point and distributed to the several members of the Committee. A supply of 016, 018, and 020 pyrometric cones was likewise distributed. Definite instructions for carrying out the tests as issued and results obtained are given. Tests seem to indicate that with a reasonably uniform rate of heating, results checking within at least $\pm 10°$ can be expected. (APPENDIX B): A comparative study of sieve and settling tests for fineness of milled enamel was made. The specifications followed in making these tests are given and data obtained are presented. Conclusions drawn are as follows: (1) For a given enamel the amount of residue retained on the 200-mesh screen bears a definite relation to the amount retained on the 325-mesh screen when used alone. The lack of similarity between the curves for the various enamels suggests that the relation between the 200-mesh and 325-mesh residues might

[1] R. D. Cooke, *Jour. Amer. Ceram. Soc.*, **7** [9], 651 (1924). See this *Bibliography*, p. 75.

vary from one enamel to another. (2) If conclusion (1) is correct the same reasoning would hold for the next step in increasing fineness and, if so, the residue retained on the 200-mesh screen is an index of the fineness of the batch as a whole. (3) The amount of settling in one minute is a small enough part of the total sediment to eliminate any serious error of type which would exist were the sediment in one minute close to the real amount in the test jar. (4) There is a definite relation between the amount of sediment in the settling test and the residue retained on a screen in the screen test. (5) The relation indicated in conclusion (4) may not be the same for different enamels ground in the same mill, or the same enamel ground in the same mill, or the same enamel ground in different mills. (6) The use of either test on a given enamel under the same milling conditions should give a reasonably accurate index of fineness; certainly when the indicated reading for sediment or residue is the same the fineness of the batch of enamel as a whole is the same, with due allowance for experimental error. It is possible that a given index of fineness would not mean the same fineness of the batch as a whole for different enamels, possibly not for the same enamel ground under different conditions. (APPENDIX C): An investigation of the Lindemann-Danielson cross-bending test for sheet-iron enamel was made with the idea that there might be possibilities for its standardization. Certain shortcomings were noted and a modified machine was built to overcome these shortcomings. Results of tests made are presented but there are discrepancies which indicate that more work must be done to determine the usefulness of the scheme. The essential modifications in the machine consisted of installing a uniformly accelerating cam so that there is a uniform travel of the load for a given rotation of the shaft. (*Ceram. Abs.*, **6**, 503 (1927); *Chem. Abs.*, **21**, 3438 (1927).)

Bull. d.'enc., p. 306 (1862); *Genie*, **24**, 216.

ENAMELING OF CAST IRON. (*Rept. der Tech. Lit.*, p. 306 (1854–1868).)

Burnham, W. M., and P. G.

MANUFACTURE OF ENAMELED IRON SHEETS. British Pat. 15,715, July 11, 1906.—The iron or steel articles to be enameled are first electroplated with a thin film of copper, after which the enamel is applied directly and fixed by heat. In the case of small articles, the sheet from which they are cut is conveniently electroplated. (*Chem. and Ind.*, **26**, 95 (1907).)

Burt, F. M.

MIXING, SMELTING, GRINDING OF ENAMELS. *Ceram. Ind.*, **7**, 40 (1926).—The first of a series of articles on the methods used in enameling practice. The correct method of enamel preparation is discussed. (*Ceram. Abs.*, **5**, 344 (1926).)

Burt, F. M.

ENAMEL MIXING, SMELTING, AND GRINDING. *Ceram. Ind.* **7**, 143 (1926).—Correct methods for raw material handling, smelting, and grinding are suggested. (*Ceram. Abs.*, **5**, 344 (1926).)

Burt, F. M.

DIPPING AND SLUSHING ENAMELWARE. *Ceram. Ind.*, **7**, 370 (1926).—Discussion of causes of hollowware defects. Ground- and cover-coat dip troubles are treated. Methods of handling sprayed and dipped ware are discussed. (*Ceram. Abs.*, **5**, 384 (1926).)

Burt, F. M.

PROGRESS IN ENAMELING. *Enamelist*, **3** [2], 14 (1925).—In 1925 approximately 125,000 T. of steel were vitreous enameled in the United States and Canada. There

were 245 enameling factories in the United States and Canada, 195 of which do some sheet steel work. The percentage of "firsts" was greatly increased. A white ground coat was used on full lines of kitchenware and flat work with as much ease and success as the regular cobalt, manganese, and nickel ground coats. A single-coated white was being perfected.

Burt, F. M.

PLANT OBSERVATIONS. *Enamelist*, **3** [3], 20 (1925).—Observations in 100 enameling plants showed: (1) that the mixing, smelting, and grinding departments are the most inefficient; (2) that 600 to 1000 smelts can be made with one smelter lining; (3) that muffle furnaces should last 18 months without major repair and 2 to 3½ years with 25% repair cost on muffles; (4) that the best pier brick should last at least 5 years; (5) that approximately a 5- x 12-foot muffle furnace running at capacity on sheet steel should use: (*a*) nine gallons oil (1,260,000 B.t.u.), (*b*) 130 lbs. coal (about 1,750,000 B.t.u.), (*c*) 1100 cu. ft. natural gas (1,100,000 B.t.u.).

Burt, F. M.

MIXING AND SMELTING DEPARTMENT. *Enamelist*, **3** [5], 9 (1926).—Descriptions of the old method of mixing by hand and the newer method using mechanical equipment are given. The latter method is by far the more efficient.

Burt, F. M.

ENAMEL VS. ALUMINUM. *Enamelist*, **3** [3], 11 (1925).—Triple-coat white enameled kitchenware in use over five years was in much better condition than aluminum ware in use eighteen months under practically the same kitchen conditions.

Burt, F. M.

APPLICATIONS OF FUELS IN ENAMELING FURNACES. *Ceram. Ind.*, **8**, 430 (1927).—A summary of the kind of enameled ware, the number of plants and furnaces, and the fuel used in the different plants are given in a table. There are 1171 enameling furnaces in 178 plants representing an investment of over four million dollars; 60% of these are said to be operating. (*Ceram. Abs.*, **6**, 212 (1927).)

Burt, F. M.

COAL IS LOW PRICE FUEL FOR ENAMELERS. *Ceram. Ind.*, **8**, 434 (1927).—The chief advantage in the use of coal as fuel in enameling is that of price. It is claimed that the quality of ware produced in a properly built and fired coal furnace, with a tight muffle, whether sheet steel, wet- or dry-process cast iron, is as good as with any other fuel. (*Ceram. Abs.*, **6**, 212 (1927).)

Burt, F. M.

GAS AS A FUEL FOR ENAMELERS. *Ceram. Ind.*, **8**, 439 (1927).—The advantages of gas as a fuel: comparatively cheap in some and very cheap in other localities, easiest to handle, best of combustion possible, very clean, best adapted to exact control, and lends itself to the evenest of heat distribution. (*Ceram. Abs.*, **6**, 213 (1927).)

Burt, F. M.

ROUTING PRODUCTION THROUGH THE PLANT. *Ceram. Ind.*, **9**, 55 (1927).—The system should cover the following points: (1) keep largest possible quantities of single or similar items together in each operation, (2) keep re-works cleaned up, (3) record exact position of any quantity of items on any order at any time, (4) provide for precedence of ware, (5) record all losses and spoilage, (6) show best production efficiencies in each operation that standards may be established, (7) show exact manufacturing costs

in individual runs of individual items, and (8) show exact piecework records which will discount possibility of cheating by operator. (*Ceram. Abs.*, **6**, 412 (1927).)

Burt, F. M.

TWELVE COMMERCIAL ENAMEL BATCHES. *Ceram. Ind.*, **8**, 216 (1927).—The following formulas were taken from this article:

	1	2	3	4	5	6	7	8	9	10
Borax	83	136	132	150	30	30	128	125	27	160
Feldspar	77	204	144	150	56	30		165	38	112
Flint	67	70	88	105	11		110	60	45	126
Kryolith	13	112		10		1	90		10	32–64
Fluorspar	16		31	20		7	10	15	8	36
Soda ash	22	24	28	45			18	40	23	24
Nitrate soda	13	15	22	25		9	10	16	5	16
Manganese oxide	3		16	3	1/2			3		
Cobalt oxide	4		3 1/2	2				1 oz.		
Iron oxide	1 1/2									
Antimony oxide		24					28	10	4	24
Red lead		36			2 1/2	8 1/2				
Gray nickel oxide				2						
Tin oxide						8				
Zinc oxide						10 1/2				28
White lead							50			
Bone ash								9		
Sodium sulphate								6		
Black needle antimony								7		

No. 1: good blue beading enamel or sign blue mill 7% clay, 35% water.
No. 2: good white enamel for copper, mill 600 lbs. frit, tin 72 lbs., clay 48 lbs., magnesium carbonate 60 oz.
No. 3: good hard ground coat, mill with 6 to 7% clay.
No. 4: medium soft ground coat, mill with 7% Valender clay and 1% soda ash.
No. 5: dry process cast-iron grip coat, mill 100 lbs. frit, 4 lbs. clay, 2 lbs. borax, 65 lbs. soft water, mill to 100-mesh.
No. 6: Dry process cast-iron cover-coat white; No. 7: wet process cast-iron cover coat; No. 8: good gray one-coat enamel for mottled kitchenware, mill with 6% clay to 40- to 50-mesh; No. 9: cheap white steel enamel; No. 10: white steel enamel.

Burt, F. M.

ADVANTAGES OF OIL FOR ENAMELING INDUSTRY. *Ceram. Ind.*, **8**, 454 (1927).—The advantage of oil as a fuel for enameling furnaces lies in its ultimate cost which, when all factors are considered, is the cheapest. Proper equipment is necessary to use oil successfully.

Burt, F. M.

THE ENAMELING INDUSTRY TODAY. *Ceram. Age*, **9**, 146 (1927).—There have been many advances in the enameling of iron and steel in the past fifteen years, among them certain developments in enamels, increased furnace and smelter efficiencies, longevity, and the use of other items of improved equipment. There has been no radical and universal reduction in the cost of enamels, the improvements being more in quality standards. A discussion of furnaces, equipment, plant practice, kitchenware, and expansion in the industry is included. (*Ceram. Abs.*, **6**, 373 (1927).)

Burt, F. M.

FURNACE AND SMELTER DEVELOPMENTS. *Ceram. Ind.*, **8**, 49 (1927).—B. traces history of enamel furnace and smelting progress and shows how the price of fuel effected changes in design. (*Ceram. Abs.*, **6**, 95 (1927).)

***Burt, Stanley, G.**

See Binns, C. F. (this *Bibliography*, p. 25).

Cannon, H. B.

OVEN OR FURNACE ADAPTED FOR HEATING ENAMELED ARTICLES. U. S. Pat. 1,550,340, Aug. 18, 1925.—A furnace or oven comprising in combination a hearth with a heating chamber thereabove, a combustion chamber within the first-mentioned chamber, means for supplying a combustible mixture to the combustion chamber for heating the latter interiorly, there being a flue below the hearth, and means for discharging the products of combustion from the chamber into the flue and beneath the hearth, the hearth being composed of material having high heat-radiating qualities. (*Chem. Abs.*, **19**, 3576 (1925).)

***Cappel, A.**

OPAQUE ENAMELS. See Kretzer, H. (this *Bibliography*, p. 182).

Carpenter, Frank J.

ENAMELING APPARATUS. U. S. Pat. 1,281,762, Oct. 15, 1918.—A plurality of contracting members for engaging the rims of articles to be enameled attached to a rotating shaft.

Carpenter, J. W.

DEVELOPMENTS IN 1921 IN ELECTRIC VITREOUS ENAMELING FURNACES. *Jour. Amer. Ceram. Soc.*, **5**, 409 (1922).—A summary of the new installations of electric furnaces during 1921 for vitreous enameling work with descriptions of various types of furnaces and operating data from various shops. (*Chem. Abs.*, **16**, 2764 (1922).)

Carpenter, J. W.

POSSIBILITIES OF ELECTRIC ENAMEL FURNACE. *Ceram. Ind.*, **1**, 77 (1923).—Enameling in the electric furnace affords temperature control and absence of combustible gases. This article is a practical record of an operating furnace.

Carpenter, J. W.

ELECTRIC HEAT RAISES ENAMELING OUTPUT.[1] *Elec. World*, **77**, 873 (1921).—Comparison is made with older types of furnaces. In marked contrast with the oil coal, and gas furnaces, the electric furnace eliminates damaged ware and makes possible the utilization of the entire heating space. Its initial cost and the fuel costs are double those of the older types, but it admits 25% increase in weight per charge and 30% in charges per hour. (1) *Description and operation:* Details of construction are given. The electrical equipment is explained together with the methods of temperature record and control. Details of operation are given. (2) *Cost of operation:* With an initial cost of $8000, the cost of the electrical power has been $2.00 per hour for a 10-hour day which would be reduced to $1.56 per hour for a 24-hour day. (3) *Production results:* With a production of 900 lbs. of ware per hour the enamel finish is more satisfactory than with the older types of furnaces. (4) *Future improvements:* Preheating chambers and double-end operation are suggested. (*Jour. Amer. Ceram. Soc.* (Abs.), **4**, 976 (1921); *Chem. Abs.*, **15**, 1978 (1921).)

***Carpenter, J. W.**

ELECTRIC VITREOUS ENAMELING OVEN. See Mehling, C. W. (this *Bibliography*, p. 214).

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[1] C. W. Mehling and J. W. Carpenter, *Jour. Amer. Ceram. Soc.*, **4**, 271 (1921).

Carter, H. D.

ACTION OF CHEMICAL CLEANERS. *Enamelist*, **5** [1], 10 (1927).—The action of cleaning compounds in removing oil and grease is discussed.

Casto, L. V.

OXVAR PROCESS FOR REPRODUCTION OF MARBLE AND WOOD GRAIN FINISHES IN VITREOUS ENAMEL. *Enamelist*, **2** [5], 11 (1925).—*I. Equipment required:* (1) metal plates bearing a reproduction of the exact detail taken from a natural wood panel; (2) combination paste spreader and scraper; (3) composition rolls with smooth surface and of proper size and design to transfer grain from plate to the surface to be grained; and (4) accessories. *II. Procedure used:* (1) one coat of ground applied, (2) ground coat fired, (3) first coat porcelain enamel of required color applied, (4) first coat porcelain enamel fired, (5) product grained according to procedure following, and (6) product fired. *III. Procedure of graining:* (1) a quantity of graining paste sufficient to cover surface is placed on plate. This operation only required when starting work; (2) paste is spread over the plate unevenly by passing the combination paste spreader and scraper forward over the plate. Surplus paste is then scraped from the surface by drawing the scraper back over the plate leaving an even coating over the entire surface; (3) proper roll for graining surface desired is then run over the plate picking up the grain from plate. This roll is then run over the surface of product to be grained, transferring the grain to such surface and completing the graining operation.

Cauwood, J. D., and Turner, W. E. S.

NOTE ON DETERMINATION OF BORIC OXIDE IN GLASS. *Jour. Soc. Glass Tech.*, **2**, 246 (1918).—Accuracy of titration is not affected by increasing the volume of solution to 300 cc. The volume, however, should be kept as low as complete washing will permit because $CaCO_3$ is then more effective in removing substances which interfere with B_2O_3 titration. Prolonged boiling of $CaCO_3$ with H_2O causes dissociation to CaO and CO_2 and therefore the bulk and time of boiling should be kept at a minimum. For zinc-free and lead-free glasses Wherry's method is satisfactory, provided filtrations and washings are carried out under suction. Up to about 3% ZnO Wherry's method may be used, but Sullivan and Taylor's method is advised for all borosilicates containing zinc or lead. (*Chem. Abs.*, **13**, 1249 (1919).)

Cawood, R. L.

GRINDING GLAZES AND ENAMELS IN PEBBLE MILLS. *Ceram. Ind.*, **7**, 254 (1926).—Practical suggestions about the manipulation of pebble mills are given. It is claimed that the largest-sized mill that can possibly be used for a given purpose is always the more economical to buy and the cheapest to operate. (*Ceram. Abs.*, **5**, 369 (1926).)

Cawood, R. L.

MODERN PEBBLE MILLS. *Enamelist*, **3** [1], 19 (1925).—For dry grinding, the grinding capacity is 25% of the total volume inside of the lining. For wet grinding, it is 60% of the volume. These figures vary somewhat depending upon the nature of the material to be ground, and upon the diameter of the mill. Different points of construction and installation are discussed.

Caye, G.

MECHANICAL PROCESS OF ENAMELING IRON. *La Nature*, p. 148, Feb. 2, 1901; *Proc. Inst. Civil Eng.*, **145**, 48 (1901).—The ordinary process for enameling iron with a lead glaze is attended with serious consequences to the health of the workmen, the fine dust of the lead compound employed not only being inhaled, but also entering the pores

of the skin. A. Dormony has invented a process of applying a coating of lead enamel to iron surfaces by mechanical means, with avoidance of injury to the health of the workpeople. The articles to be enameled, after being heated to redness, are placed in a double, hermetically sealed chamber, with glazed sides; each half of the chamber can be worked alternately, and the surplus enamel powder, which is dusted over the metal by means of a sieve, is removed from the chamber by the draft from a high chimney. The mechanism for introducing and rotating the objects to be enameled is worked from the outside of the chamber; the sieves are subjected to a vibratory motion by means of an electrical beater. The new process has proved successful in working. (*Chem. and Ind.*, **20**, 989 (1901).)

Ceram. Age, **9**, 7 (1927).

NOTABLE ENAMELING PLANTS AT DETROIT.—A description, with photographs, of the rapid-production methods and equipment used in four enamel plants in Detroit. (*Ceram. Abs.*, **6**, 133 (1927).)

Ceram. Age, **9**, 73 (1927).

DEVELOPING CLOSER CONTROL OF ENAMEL.—Review of several papers read at the annual session of the Enamel Division of the AMERICAN CERAMIC SOCIETY.

Ceram. Age, **9**, 177 (1927).

LIGHT-COLORED FIRST-COAT ENAMELS FOR SHEET IRON.—A short progress report of a Bureau of Standards investigation to eliminate the necessity of a first dark coat in enameling sheet iron either by developing a light-colored enamel having an adhesiveness comparable to a cobalt enamel or by improving the technique of application so that white enamels can be made to adhere sufficiently, or both. Two opacifiers give promise of satisfactory behavior for this use and a test for adherence which has been developed shows promise of giving valuable data. (*Ceram. Abs.*, **6**, 505 (1927).)

Ceram. Age, **10**, 66 (1927).

INVESTIGATION OF FELDSPAR BY THE BUREAU OF STANDARDS.—Bur. Stand., *Bull.*, No. 117 (1927); see *Ceram. Abs.*, **6**, 152, 387 (1927).

Ceram. Age, **10**, 157 (1927).

CERAMIC INVESTIGATIONS AT THE BUREAU OF STANDARDS.—Short reviews of the ceramic investigations at the Bureau of Standards.

Ceram. Ind., **1**, 31 (1923).

ENAMEL PLANT APPLIES MODERN TOOLS OF BUSINESS TO WIN SUCCESS.—Technical men, cost system, time study, and labor committees form part of equipment of efficient plant of Benjamin Electric Mfg. Co.

Ceram. Ind., **1**, 130 (1923).

LARGE SMELTING PRODUCTION CLAIMED FOR ROTARY ENAMELING FURNACE.—This article describes the use of a rotary furnace for smelting enamel. Some of the advantages are: (1) fused mass is homogeneous; (2) danger of contamination is eliminated; (3) fire under complete control; (4) low fuel consumption; and (5) less labor required.

Ceram. Ind., **1**, 178 (1923).

PRODUCE 560 SQUARE FEET OF ENAMEL SIGNS EVERY WORKING HOUR.—Description of the process of the Federal Electric Co., Chicago, Ill. Installation of modern

machinery and the rearranging of routine schedule has lowered operating costs and increased output.

Ceram. Ind., **1**, 226 (1923).

PRODUCTION INCREASED BY INSTALLING NOVEL MACHINERY IN ENAMELING SHOP.—Constant improvements have made it possible to maintain a daily production of 10,000 square feet of sheet steel enameled ware at the Wrought Iron Range Co. of St. Louis, Mo.

Ceram. Ind., **1**, 276 (1923).

UNUSUAL ENAMELING IDEAS.—Grand Rapids (Mich.) Refrigerator Co. produces 80,000 linings and 20,000 inside-outside boxes per year. Much time and labor-saving apparatus has been installed by Mr. Bardush, Supt. Enameling Dept., to make this production possible.

Ceram. Ind., **1**, 284 (1923).

EXPERTS ON FURNACE DESIGN BUILD SMELTER FOR ENAMELS OR FRITS.—Details and description of furnace built for the Northwestern Terra Cotta Co., at Chicago, Ill. The combustion chamber is 4 feet wide at the burner end, narrowing down to a 2-foot opening into the smelting chamber; the entire length of the chamber is about 30 inches. This length was found requisite in order to burn the oil completely. An arch with a turtle-back shape was incorporated in the design. Thus advantage is taken of radiation and a slow passage of the hot gases rather than the high velocity "squeeze" method of the old type of furnace.

Ceram. Ind., **1**, 333 (1923).

SPEED UP ENAMEL PRODUCTION WITH CONTINUOUS SPRAYER AND DRIER.—The process of the A. B. Stove Co. of Battle Creek, Mich., is given. A great deal of time and labor is saved by the use of continuous sprayer and drier. The main spray booth is 5 feet in length and $5^1/_2$ feet high. The conveyer passes through the spray booth at the rate of approximately 15 feet per minute. The ware is placed on the belt by a workman and sprayed as it passes through the hood. At the issuing end of the sprayer is a continuous drier, 44 feet in length. The ware is placed on the drier apron and sent through at a specified rate of speed. The temperature in the middle of this drier is kept at 150°C. Air entering the drier is preheated by waste heat from the furnace stacks. The handling of raw materials and smelted enamel is described.

Ceram. Ind., **2**, 30 (1924).

CHAIRMAN'S REPORT SHOWS NECESSITY FOR ADEQUATE ENAMELWARE TARIFF.—Low labor costs and depreciation of currency assist foreign competitors to sell their ware cheaper than cost of manufacture in the United States. Opinions of English manufacturers urge protective tariff.

Ceram. Ind., **2**, 41 (1924).

GERMAN ENAMELED SANITARY WARE COMPETITION FELT.—Increasing competition from continent manufacturers becomes very marked in England. Czechoslovakia is a formidable pottery competitor.

Ceram. Ind., **2**, 92 (1924).

HIGH QUALITY ENAMEL PRODUCT PROVES THAT CLEANLINESS PAYS.—Outstanding features taken at the plant of Cribben and Sexton Mfg. Co., Chicago, Ill.

Ceram. Ind., **2**, 102 (1924).

TABLE TOPS SOLE OUTPUT OF PLANT.—The process of the Nappanee, Ind., plant of the Vitreous Steel Products Co. The metal sheets are swabbed with a soap and

water solution before pressing. The sheets are then cleaned and pickled in hot sulphuric acid bath. The acid and soda bath are tested daily. This has resulted in considerable saving in ware and material. All three coats applied to the table tops are dipped or slushed on. Waste heat is used for drying. The ware is fired in four coal-fired furnaces, each capable of firing fourteen loads of table tops with four large tops to the load every hour.

Ceram. Ind., **2**, 158 (1924).

ENAMELWARE MEN HOLD PROFITABLE SESSION.—Résumé of papers and discussions of 26th annual convention of the AMERICAN CERAMIC SOCIETY at Atlantic City.

Ceram. Ind., **2**, 215 (1924).

DOUBLE FURNACE OPERATED BY ONE CREW AT HUGE ENAMELING PLANT.—Ingram-Richardson Co. at Bayonne, N. J., reduces working force by use of automatic, continuous drying ovens, and double furnace operated by one crew. Attention to working conditions reduces labor turnover.

Ceram. Ind., **2**, 279 (1924).

ENAMELING PLANT USES NEW TYPE DUST COLLECTOR SYSTEM.—An unusually large amount of enamelware for a plant of its size is produced by the Roberts and Mander Stove Co. at Hatboro, Pa. The various departments are so arranged that the ware moves from the incoming raw metal base to the finished porcelain-enamel product in a most efficient and economical manner. The various steps in the process are described in considerable detail.

Ceram. Ind., **2**, 353 (1924).

ROTARY SPRAYING BOOTH TURNS OUT 720 AVERAGE PIECES OF ENAMELWARE HOURLY.—The new plant of the Chicago Vitreous Enamel Products Co. covers 100,000 sq. ft. of floor space. The equipment of the pickling room includes Monel metal baskets or hoists and individual drying rooms. By the use of baskets the ware is advanced in lots from one tank to another. The steel spray room is equipped with duplex spray booths, each equipped with individual motor and fan. In addition to their own requirements immense quantities of frit mixtures are made for the trade. The frits are tested in actual production before release. The capacity of each frit furnace is 1000 lbs. of raw material. The smelting is completed in less than two hours. One thousand or more smelts are made before the smelter requires relining. The smelter room is well equipped with apparatus for the removal of irritating fumes. The frit furnace men are given one week a month off during which time they are employed in less strenuous work. The frit smelters are operated with oil for fuel. The capacity of each smelter is from 12,000 to 22,000 lbs. per 24 hours. There are two types of continuous sprayers used, the conveyer type and the rotary type. Seven hundred and twenty pieces of flat work are sprayed per hour in the rotary machine. The minimum production of the cast-iron spraying room is 24,000 lbs. every eight hours. Portable enamel tanks are used. Separate driers are used for the cast-iron and sheet-iron ware. Waste heat from the furnaces is utilized to heat the driers. The plant was originally equipped with coal-fired furnaces, each having a capacity of 1600 sq. ft. of sheet ware per 24 hours. The cost of fuel labor and upkeep was approximately $22.00 per thousand sq. ft. Intermittent gas-fired furnaces were next installed. Their capacity was also 1600 sq. ft. of sheet ware per 24 hours. The cost of firing ranged from $26.00 to $30.00 per thousand sq. ft. The Carborundum muffle type of furnace now in use in connection with the speed fork delivers 3000 to 4000 sq. ft. of sheet ware every 24 hours. Oil, which is used for fuel, costs 6 cents per gallon delivered to the burners. The cost of firing ranges from $3.75

to $5.00 per thousand sq. ft. The cast-iron furnaces have a capacity of 12,000 lbs. of once-fired ware every 24 hours. The cost of firing is approximately 50 cents per one thousand pounds. Bonuses are paid on all firing work in order to maintain a high standard both in rate of production and quality of ware. The shipping crates have been standardized in order to prevent damage to the ware and to eliminate wrapping. An allowance is given the addressee on returned crates. A sandblast barrel of the direct pressure type is used for cleaning. From 800 to 1500 stove legs are cleaned in this barrel per 8-hour shift. Hose machines are used on larger pieces. The entire shop is operated with oil for fuel with duplicate equipment. Four 10,000-gallon tanks constitute the oil storage. (*Ceram. Abs.*, **3**, 239 (1924).)

Ceram. Ind., **3**, 22 (1924).

UNIQUE PICKLING-SYSTEM HUMIDITY DRIERS CUT COSTS IN ENAMELING PLANT.[1]—Single-coated grayware and triple-coated whiteware are produced. Small wooden carts are used to carry the raw materials from the bins, over the scales to the rotary mixer in 1500-lb. batches. The batches are mixed for two minutes and elevated to 12,000-lb. storage hoppers. A conveyer bucket carries the mixed raw materials in 1100-lb. batches to the smelting room. The smelting is done in two tilting rotary furnaces, the combined daily capacity of which is 9 batches of 850 lbs. each, the time required being $2^1/_4$ hours. The frit storage bins are calibrated in order to facilitate the taking of inventory. Fourteen 5-ft. ball mills are provided for frit grinding. The frit is ground in 1000-lb. batches until a test shows it has been ground sufficiently, which requires about 10 hours. The test is made by drawing a 100-cc. sample of enamel, through a one-inch pipe inserted permanently in the mill, mixing it with a given volume of water and allowing it to settle in a graduate for one minute. The ground enamel is unloaded from the mills with the aid of compressed air into zinc-lined carts which transfer the enamel into storage tanks in the dipping room. The annealing of the metal which is necessary after two or three draws is done in a continuous furnace at 1500°F. The completed metal shapes are sent through a continuous scaling furnace at 1300°F. Dovetailed wooden pickling baskets are used, each having an average capacity of 100 pieces of ware. Rubber straps and a hand windlass are used for lowering and raising the baskets. The ware is kept in a sulphuric acid bath for 10 minutes, rinsed in water, and placed in a soda neutralizing bath. The acid tanks are built of 3-inch cypress with pitch-calked joints. The soda and water tanks are built of 2-inch pine with calked joints. A chain drier conveys the carts of pickled ware into the dipping and spraying room. The enamel is fed to the spray guns under a 4-foot gravity head and atomized with an air pressure of 80 lbs. Individual dipping and spraying booths are used. The triple-coated ware is dried in driers at 180°F, whereas the grayware is dried in the open. Each of the 8 driers holds 6 trucks with a combined capacity of from 1200 to 1500 pieces of ware. Ware requiring 2 to 3 hours to dry in the open is dried in 15 minutes in the drier. There are 12 coal-fired furnaces of the recuperator type equipped with fireclay muffles and Carborundum hearths. The grayware is fired at 1700°F, the triple-ground coat at 1750°F, and the cover coats at 1600°F. An optical pyrometer is used to measure the temperatures. All furnaces average 15 loads per hour and operate on a 24-hour schedule. The furnaces operating at 1700°F produce 6 tons of ware every 24 hours on 3600 to 4000 lbs. of Indiana coal screenings bought at $2.00 per ton. (*Ceram. Abs.*, **3**, 260 (1924).)

Ceram. Ind., **3**, 99 (1924).

INTERCHANGEABLE AIR SYSTEM REDUCES COSTS IN ENAMELING PLANT.[2]—Cast-iron

[1] The Columbian Enameling and Stamping Co., Terre Haute, Ind.

[2] Report of visit to The Vitrified Iron Products Co. of Clyde, Ohio.

and sheet-steel porcelain enamel ware are manufactured. The cast-iron pieces are kept in a drier until enameled, after being sandblasted. The sheet steel is left in the cleaning tank from 7 to 10 minutes and is pickled for about 7 minutes. The baths are kept near the boiling point with open steam jets. The smelter has a capacity of smelting 800 lbs. of raw material in 2 hours. The recuperation principle is very effectively employed, the primary air being preheated to 700°F. Low-pressure air and high-pressure oil are used in the burners. The hearth of the smelter is built in the form of the letter "V" with a slope of about 20° from the back wall to the tap hole. An interchangeable air compressor and fan arrangement permits continuous operation throughout the plant. The driers are gas heated and equipped with canvas doors. The furnaces are oil fired and equipped with 3 recuperators. A uniform temperature is insured throughout the length of the furnace by having the openings to the recuperator chambers at the front of the furnace. The 8-inch oil burners operate on 60-lb. oil pressure and 12-oz. air pressure. From 8 to 9 gallons of oil are required per hour to fire from 400 to 600 sq. ft. of sheet steel or over 400 lbs. of cast iron. The sheet-steel ground coat is fired at between 1650 and 1675°F and the cover coat at between 1625 and 1640°F. The cast-iron enamel is fired at between 1350 and 1400°F. The temperature is measured with pyrometers and the time with sand clocks. (*Ceram. Abs.*, **3**, 313 (1924).)

Ceram. Ind., **3**, 165 (1924).

AUTOMATIC EQUIPMENT LOWERS ENAMEL SMELTING COST.—The new plant of the Porcelain Enamel and Manufacturing Co., Baltimore, Md., is described. The general plan of this plant permits the materials to progress in one direction from the raw state to the shipping room and the excellently appointed position of the various parts of the processing increases the efficiency and makes possible lower production costs, at the same time resulting in better work. The plant operates 24 hours a day, and due to the fact that it has specialized on particular products it can produce these at exceptionally low costs. Electric hoists are used throughout the plant and a research laboratory, with a competent chemist in charge, is ever working on new application methods, new uses for enamels, new colors, eradicating faults, and eliminating troubles.

Ceram. Ind., **3**, 231 (1924).

THREE FURNACES ENAMEL 24,000 POUNDS CAST, 14,000 SQUARE FEET SHEET IRON DAILY.—Both cast iron and sheet iron are enameled at the plant of the American Radiator Company, Buffalo, N. Y. This necessitates a segregation of departments. The raw batch usually in 1000-pound lots, is mixed for 40 to 60 seconds in a concrete mixer which has, in addition to a rotary motion, an accompanying parabolic motion. The smelting is done in four oil-fired smelters. A temperature of 2200°F is used for cast iron, and a temperature of 2800°F for sheet iron. The smelters are charged from a mezzanine floor by using batch carts. The percentage of water which is added to the mills is handled through a large water tank equipped with a gage. The cast-iron enamel is ground in 8 hours, while the sheet-steel enamels require 6 to 7 hours to grind. The cast-iron drier will dry 2000 pounds of castings in about $3^1/_2$ minutes. A temperature of 183°F is maintained by an oil burner at one end of the drier. The conveyer for the sheet iron ware passes through a 60-foot hollow tile drier. The air spaces in the tile act as an insulator; 24,000 sq. ft. of dipped ware are sent through this drier every day. The firing department consists of large electric furnaces, having 5- by 10-foot inside dimensions, which consume 200 kw. per hour. It has been found that the electric furnace is, for this plant, the most economical type to operate. Sheet steel is fired at about 1700°F, and the furnace, when set at this temperature, will maintain this temperature constant to within five degrees. The cast-iron work is fired at 1340°F.

Ceram. Ind., **3**, 252 (1924).

UNUSUAL PRODUCTION CLAIMED FOR NEW AUTOMATIC SPRAY BOOTH.—The Wrought Iron Range Co., St. Louis, Mo., has lately developed spraying devices that have increased production 50%. The newest development is as follows: The conveyer mechanism consists of five strands of specially made copper wire rope stretched taut over pulleys, and is driven by a small electric motor. The spraying device is unique in design. To the rim of the main drive wheel a connecting rod is fastened. This rod is connected in turn with another which is, in turn, coupled to the spraying device. The spraying device, which is weighted, travels along an overhead rail located at the top of the booth, which is fitted with a glass front that can be raised. The spray gun and speed of the conveyer are so adjusted that a heavy uniform coat of enamel is deposited on the sheet iron as it passes through the booth.

Ceram. Ind., **3**, 306 (1924).

ENAMEL 11,600 POUNDS OF CAST IRON PER FURNACE DAILY.—Handy arrangement of every process cuts costs at Tennessee Enamel and Manufacturing Co., Nashville, Tenn. Even though the production of the plant is small, it is claimed that cast-iron enamels are produced at a cost of thirteen cents per pound and sheet metal enamel for six cents per pound. The plant has a production of 11,600 pounds of cast iron per 23 hours together with an average of 7000 square feet of sheet metal.

Ceram. Ind., **3**, 324 (1924).

LABOR REDUCTION IN PICKLING ROOM, 87½%.—Electric hoist eliminates labor at Quick Meal Stove Co., St. Louis, Mo. The new equipment requires only one man where eight were formerly used.

Ceram. Ind., **3**, 381 (1924).

STAGING A COMEBACK WITH NEW ENAMEL FURNACES AS A BASIS.—The remodeled plant of the Wolff Mfg. Corp., of Chicago, Ill., is described. Eight double and 2 single Carboradiant furnaces were built. The details of the furnace are shown and the operation described in drawings. The fuel oil is carried at 50-lb. pressure with air at 1½-lb. The combustion chambers are made of Carborundum. The heat from the waste gases which are by-passed through a vertical tube boiler is utilized to furnish hot water for the entire heating system of the plant. (*Ceram. Abs.*, **4**, 61 (1925).)

Ceram. Ind., **3**, 412 (1924).

CABINET SANDBLAST PROVES POPULAR.—The Crown Stove Co. of Chicago, Ill., has an 8 ft. humane type, direct pressure sandblast cabinet of the Mott type which has a capacity of 47,000 lbs. of castings per month by using 2 men for 26 ten-hour days. The operator directs his work through celluloid panels from the outside and sometimes finds it necessary to wear goggles but never a mask. (*Ceram. Abs.*, **4**, 62 (1925).)

Ceram. Ind., **4**, 30 (1925).

ENAMELING FURNACE DESIGN.—The advantages and disadvantages of different types of furnaces, the fuels used in each, and the principles of successful operation are discussed. There are a number of sketches showing different types of furnace construction including the new electric rotary continuous furnace. A large amount of enameling furnace data, resulting from questionnaires, is given in tabular form and discussed. (*Ceram. Abs.*, **4**, 61 (1925).)

Ceram. Ind., **4**, 156 (1925).

NEW SMELTER AND DRIER COMBINATION.—A double smelter is described in which the ground and cover coats are fritted, one at either end. (*Ceram. Abs.*, **4**, 126 (1925).)

Ceram. Ind., **4**, 200 (1925).

REPORT OF PAPERS READ IN ENAMEL DIVISION.—Résumé of papers presented at the AMERICAN CERAMIC SOCIETY meeting held at Columbus, Ohio.

Ceram. Ind., **4**, 278 (1925).

BONUS SYSTEM BOOSTS PRODUCTION.—The plant and operation of the Challenge Refrigerator Co. of Grand Haven, Mich., is described. (*Ceram. Abs.*, **4**, 214 (1925).)

Ceram. Ind., **4**, 376 (1925).

NOVEL HEATING SYSTEM IN ENAMEL PLANT.—Features of the Mansfield (Ohio) Vitreous Enameling Co. plant. Interesting installations that are to be found in this plant include a suction system, electric enameling furnace, spring cushions which aid in saving the wear and tear on furnace doors, a unique heating system, and the use of distilled water in grinding enamels. All tools used for border work are standardized. The daily oil supply is drawn into a tank and heated before being used.

Ceram. Ind., **4**, 457 (1925).

INCREASE FORK PRODUCTION 75%.—A home-made charging fork which increased production 75% is described.

Ceram. Ind., **4**, 458 (1925).

RECORD OF ONE-MAN FURNACES.—Salient points in the process of the enameling shop of the Detroit (Mich.) Stove Works. The sandblast room of this plant is exceptionally interesting. Each burner averages about 250 sq. ft. per hour.

Ceram. Ind., **5**, 36 (1925).

NEW IDEAS FOR ENAMELING PLANT.—Interesting points at the plant of the Wolverine Porcelain Enameling Co., Detroit, Mich., are: (1) pickling process, (2) dipping tanks moved rather than the ware, (3) continuous spraying apparatus, (4) high production with one-man furnaces, (5) temperature control of furnaces, and (6) reclamation of waste enamel.

Ceram. Ind., **5**, 130 (1925).

NEW TYPE FORK RAISES PRODUCTION 200%.—Estate Stove Co. of Hamilton, Ohio, has separate shops for cast- and sheet-iron work. Novel speed carriage and fork designed by Bert Kahn, general manager of the company, has increased production 200%. Individual pyrometers form part of the furnace equipment.

Ceram. Ind., **5**, 146 (1925).

HOW TO CURE UNEVEN ENAMEL DRAINING.—The alkalinity of the bath should be kept constant so as to prevent setting effect of alkali film.

Ceram. Ind., **5**, 228 (1926).

ENAMEL PLANT WITH THIRTY YEARS' EXPERIENCE HAS MANY NEW IDEAS.—An illustrated description of the new plant of the Ironton (Ohio) Stove and Mfg. Co. (*Ceram. Abs.*, **4**, 331 (1925).)

Ceram. Ind., **5**, 233 (1925).

PYROMETERS ABUSED IN ENAMEL PLANTS.—What to do and what not to do. (*Ceram. Abs.*, **4**, 331 (1925).)

Ceram. Ind., **5**, 236 (1925).

SAVE 4000 POUNDS WASTE ENAMEL MONTHLY.—The reclaiming apparatus at the Belleville (Ill.) Enameling and Stamping Co. is of the standard suction type with the

exception that a pipe of exceedingly large diameter is used and a relatively short distance of carrying permits an almost complete recovery of the waste enamel. The pickling tanks at this plant are lined with acid-proof brick. A home-made fork in use at this plant has been very efficient.

Ceram. Ind., **5**, 342 (1925).

NEW TYPE DRIER-RECUPERATOR FURNACE.—The Floyd-Wells Stove Co. at Royersford, Pa., has a new type reclaiming system and a recuperator which is used to feed preheated air to the burner and also to the drier. This drier is of regular design but has several new ideas regarding the method by which the air is circulated within. The cars which contain the freshly-sprayed enameled sheets are equipped with a new ball-bearing rolling device.

Ceram. Ind., **5**, 422 (1925).

RIGID CUPOLA, SANDBLAST REGULATION PRIME FACTORS FOR GOOD ENAMELING.—The Buckwalter Stove Co. at Royersford, Pa., analyzes each cupola charge and inspects every sandblasted casting thoroughly. Steel grit has been used advantageously at this plant. The manganese content of the casting is important and should run between 0.40 and 0.60. As little facing as possible is used in order to avoid a thin scale or film which might be difficult to remove by sandblasting. Electric furnaces, controlled automatically, are used for firing the ware.

Ceram. Ind., **5**, 427 (1925).

IMMENSE CONVEYING SYSTEM INSTALLED IN GERMAN ENAMELING PLANT.—Drawings of an up-to-date German plant are reprinted from *Keramische Rundschau.*

Ceram. Ind., **5**, 526 (1925).

THREE ROTARY ELECTRIC FURNACES ENAMEL 11,780 SQUARE FEET, TRIPLE COAT DAILY.—The plant of the Detroit Vapor Stove Co., Detroit, Mich., is described. Ware is pickled on a continuous conveyer, dried in a continuous drier, and enameled in rotary electric enamel furnaces. The plant has many novel features. (*Ceram. Abs.*, **5**, 45 (1926).)

Ceram. Ind., **5**, 532 (1925).

PORCELAIN ENAMELED ROOFING TILE (DETROIT, MICH.).—This enameled tile weighs only about one-third the weight of slate and about one-sixth the weight of tile is required for the proportionate area. The use of enameled tile will save in construction costs and will have the durability of roofing materials that costs much more.

Ceram. Ind., **6**, 40 (1926).

FISHSCALING OF SHEET-IRON ENAMELS.—The article contains the opinion of seven prominent enamel men on the causes and prevention of fishscaling. The chief causes advanced are: (1) composition of the enamel, (2) improper smelting, (3) improper milling, (4) character of the clay used, (5) character of the iron, (6) improper pickling of the iron, (7) underfiring, (8) overfiring, (9) type of furnace, and (10) leaking of muffle doors. See articles by following authors: J. E. Hansen, Clayton Houpt, John Hartman, Frank Jaeger, Henry Karbstein, A. E. Krebs, W. F. Wenning, and Laurence Bridge (*Ceram. Abs.*, **5**, 81 (1926); *Chem. Abs.*, **20**, 3220 (1926).)

Ceram. Ind., **6**, 154 (1926).

COPPER-LINED DRIER AND QUENCHING BUCKET KEEP ENAMEL CLEAN.—A description of the enamel department of the Dayton Porcelain and Enameling Co. is given. The quenching tank and drier are lined with copper in order to cut down possibility of

specks. The two furnaces used in firing the ware have exceptionally low fuel consumption, due to heavy insulation. (*Ceram. Abs.*, **5**, 116 (1926).)

Ceram. Ind., **6**, 272 (1926).

ENAMELERS HEAR MANY SPLENDID PAPERS.—Report of papers read at AMERICAN CERAMIC SOCIETY Meeting at Atlanta, Ga.

Ceram. Ind., **6**, 391 (1926).

BUREAU OF STANDARDS STUDIES COMMERCIAL FELDSPARS AND CONTROL OF CLAY SUSPENSIONS.—Brief review of the work being done by the Bureau on feldspars and clay suspensions.

Ceram. Ind., **6**, 479 (1926).

A TRIP THROUGH A BRITISH ENAMEL PLANT.—A description of the method of manufacturing enamelware as practiced in England. (*Ceram. Abs.*, **5**, 384 (1926).)

Ceram. Ind., **6**, 582 (1926).

PRINCIPLES UNDERLYING PROPERTIES OF ENAMEL SUSPENSIONS.—A preliminary report on the work done at the Bureau of Standards. A number of tests have been made to determine the effect of added electrolyte on the two solid phases of an enamel slip. Two factors seemed apparent from these tests: (*a*) that very small concentrations of electrolytes affect the clay suspensions, and (*b*) that where the effect was visible it was flocculation in the case of the frit and deflocculation in the case of the clay. Epsom salts was the electrolyte used. (*Ceram. Abs.*, **5**, 343 (1926).)

Ceram. Ind., **6**, 583 (1926).

SPRAYING BOOTH KEPT FREE OF ENAMEL DUST BY UNIT SUCTION SYSTEM.—This booth was designed by John Bardush of the Grand Rapids (Mich.) Refrigerator Co. The booth contains three large apertures through which the enamel dust is whisked to fall either into a water basin or, if too fine, to go up to the stack. Each of the two ducts along the side of the booth is equipped with small auxiliary fans which aid considerably in keeping the dust moving.

Ceram. Ind., **6**, 584 (1926).

BURNER CHANGE INCREASES PRODUCTION.—Description of several pieces of equipment as used at the enameling plant of the Belding-Hall (Mich.) Co. Among these is a pair of huge enameling furnaces using recuperated air. The burner is supplied with fuel oil kept at a constant temperature of 135°F. A large flame burner was needed as the combustion chamber had the unusual length of 9 feet. The present burner throws the flame 8 feet into the chamber and while it uses one to two gallons of oil more per hour than the former burner, it increases the capacity of the furnace 33%. (*Ceram. Abs.*, **5**, 343 (1926).)

Ceram. Ind., **6**, 586 (1926).

RELATION BETWEEN ENAMEL AND STEEL STUDIED BY THE U. S. BUREAU OF STANDARDS.—A study of the effect of varying the feldspar and flint content of enamels on the resistance to mechanical and thermal shock. (*Ceram. Abs.*, **5**, 344 (1926).)

Ceram. Ind., **7**, 141 (1926).

A LABORATORY CONTROLLED ENAMEL PLANT.—The Chicago Hardware Foundry Co. has proved that laboratory control properly conducted is of inestimable value to the plant. The over-all scrap loss at this plant is 5%. Description of equipment used at this plant is given. (*Ceram. Abs.*, **5**, 344 (1926).)

Ceram. Ind., **7**, 366 (1926).

MIXING ENAMELS.—In dealing with cast-iron enamels great care should be taken to mix thoroughly and smelt slowly to prevent defects from appearing on the ware. The lower the furnace temperature is when the raw batch is introduced the longer will be the smelting time. It is better to smelt slowly than fast because in slow firing there will be a more homogeneous mass with more life to it; *i.e.*, providing other things are equal, it will be a glossier, stronger, and tougher enamel. (*Ceram. Abs.*, **5**, 384 (1926).)

Ceram. Ind., **7**, 472 (1926).

RAW MATERIALS.—A comprehensive compilation of data on raw materials used in the production of ceramic ware.

Ceram. Ind., **8**, 218 (1927).

MODERN TREND IN ENAMEL KITCHEN EQUIPMENT.—The possibilities of modernizing kitchens offers a vast opportunity for enameled products. (*Ceram. Abs.*, **6**, 133 (1927).)

Ceram. Ind., **8**, 301 (1927).

INVESTIGATION OF FELDSPAR.—A survey of the work of the Bureau of Standards on the investigation of the raw materials entering into the compositions of the whiteware bodies and the effects of variations of the raw material on the qualities of the finished products. (*Ceram. Abs.*, **6**, 184 (1927).)

Ceram. Ind., **8**, 324 (1927).

ABSTRACTS OF PAPERS DELIVERED AT AMERICAN CERAMIC SOCIETY MEETING (ENAMEL DIVISION).—Short review of papers read at Annual Meeting held in Detroit. (*Ceram. Abs.*, **6**, 198 (1927).)

Ceram. Ind., **8**, 420 (1927).

REFRIGERATOR BOOM HELPS ENAMELING INDUSTRY.—This rapidly growing industry offers big opportunity for enamelers. Consumers will eventually demand porcelain enameled refrigerators.

Ceram. Ind., **8**, 428 (1927).

SANITARY WARE MANUFACTURERS SHOW INTEREST IN ACID-RESISTING ENAMELS.—Meeting was held by seventeen dry-process enamel manufacturers and this question discussed. A fellowship for research on this problem is now under consideration.

Ceram. Ind., **8**, 428 (1927).

BUREAU OF STANDARDS FINISHES STUDY ON FIRST COAT ENAMELS.—Short note on this work which the Bureau of Standards has completed.

Ceram. Ind., **8**, 429 (1927).

ALL-STEEL KITCHEN FURNITURE WIDENS ENAMEL MARKET.—The development of steel furniture for kitchens offers possibilities for the enameling industry.

Ceram. Ind., **8**, 430 (1927).

SELECTING CERAMIC FUELS.—The trend in all ceramic plants is toward a fuel that produces a clean furnace condition, is capable of being accurately controlled with regard to both temperature and atmospheric conditions, is simple to handle or apply, and is reasonable in cost per 1,000,000 B.t.u. and in cost of furnace operation and maintenance. There is a proper balance between these factors as to the best fuel for any definite ceramic product. (*Ceram. Abs.*, **6**, 212 (1927).)

Ceram. Ind., **8**, 576 (1927).

REFRACTORY ACID-RESISTING ENAMELS.—The value of annealing the metal is pointed out. The castings should be painted with acid before sandblasting. The castings should be cleaned with filtered high pressure air before they are enameled. Formulas are given for ground and cover-coat enamels. The ground coat suggested is:

Sand	360
Sodium nitrate	103
Borax	114
Soda ash	64
Cryolite	0.75
Manganese oxide	0.25

Smelting loss 23.9%
Refractory ratio 2.24
Mill with 5% clay and 40% water

The cover coat suggested for criticism is:

Sand	360	Sodium nitrate	150
Borax	117	Smelting loss	21.3%
Red lead	84	Fluxing ratio	0.666
Barium carbonate	54	Mill mix	5% clay (Valender) 7.2% Opax 40% water distilled

(*Ceram. Abs.*, **6**, 266 (1927).)

Ceram. Ind., **8**, 655 (1927).

THE ALL-CERAMIC KITCHEN.—The development of steel furniture and modern kitchen equipment has made the all-ceramic kitchen possible. The modern kitchen owes its beauty, brightness, sanitation, durability, and easy cleaning features to ceramic products.

Ceram. Ind., **8**, 657 (1927).

USING WASTE HEAT TO AID PRODUCTION.—Description of the Aetna Porcelain Co., Chicago, Ill. Waste heat quickly dries the slush coat. (*Ceram. Abs.*, **6**, 352 (1927).)

Ceram. Ind., **8**, 658 (1927).

FIND METAL RACKS MORE ECONOMICAL.—At the Roesch Enamel Range Co. both wooden and metal racks were tried out. The new type of cast-iron rack was found to be very flexible. At this plant a single blower is hooked up to supply air to two furnaces to aid vaporization of fuel. An automatic cut-off shuts off the air if the oil fails and *vice versa*. If the power fails both oil and air are shut off.

Ceram. Ind., **8**, 663 (1927).

GIVE EQUIPMENT LONGER LIFE.—A few shop suggestions from the Buckeye Porcelain Enamel Plant. Equipment should be cleaned frequently, protected while not in use, and inspected from time to time to insure perfect condition.

Ceram. Ind., **8**, 664 (1927).

GOOD MIXING REDUCES SMELTING COST.—A description of a few features found at the plant of the Superior Enamel Products Co. A mixer, which was found to give much better distribution of cobalt in the ground, cuts down smelting time 25%, and gives a better enamel, is described. (*Ceram. Abs.*, **6**, 327 (1927).)

Ceram. Ind., **8**, 688 (1927).

GLASS, ENAMEL, AND POTTERY RESEARCH DATA.—An abstract of the report of the meeting of the Advisory Committee on Ceramics of the Bureau of Standards is given. The work of the Bureau of Standards during the last year on the following subjects is reported: (1) feldspars, (2) glass, (3) sagger clays, (4) enamels, (5) enamel slips, (6)

comparison of English and American china clays, (7) effect of the chemical composition on (*a*) the modulus of elasticity, (*b*) tensile strength, and (*c*) coefficient of expansion of glazes. (*Ceram. Abs.*, **6**, 361 (1927).)

Ceram. Ind., **8**, 722 (1927).

DIRECT METHOD OF MECHANICALLY GRAINING PORCELAIN ENAMEL.—A description of this method of graining is given. The following equipment is required: (1) a composition graining roller with grain molded on face, (2) a plate glass inking platen, (3) a composition rubber roll for spreading the graining oxide over the inking platen. (*Ceram. Abs.*, **6**, 327 (1927).)

Ceram. Ind., **9**, 265 (1927).

WASHERS ADOPT "ENAMEL FOR PERMANENCE."—A description of the plant of the Altorfer Brothers where enameled washing machines are made. Monorail conveyer and waste-heat drier are features in the new plant. (*Ceram. Abs.*, **6**, 546 (1927).)

Ceram. Ind., **9**, 392 (1927).

RAW MATERIALS.—Information and data alphabetically arranged on chemicals, minerals, and other products that are of interest to manufacturers of ceramic ware are contained in this article. The following information on the materials is given: definition, occurrence, composition, uses, effect of the material on the properties of the various ceramic bodies. An estimate of the quantity of the various raw materials used annually in the various branches of the ceramic industry is made. (*Ceram. Abs.*, **6**, 612 (1927).)

Ceram. Ind., **9**, 558 (1927).

ROUTING WARE THROUGH THE ENAMELING PLANTS WITH LEAST COMPLICATIONS.—The enameling department of the Alaska Refrigerator Co. has a routing system with card record that has proved practical and least troublesome. Rollers take incoming sheets to storage pile. Portable racks are used for short firing storage.

Ceram. Ind., **9**, 561 (1927).

HOW THE BRITISH ENAMELER MAKES HIS WARE.—An article telling about the progress made in the British enameling industry. The plants are fewer in number but larger in capacity. There is a tendency toward oil for fuel. Double- and treble-decked loads are a thing of the future.

Ceram. Ind., **9**, 650 (1927).

REGULATING AND CONTROLLING DEVICES FOR CERAMIC PROCESSES.—Description of application of controlling devices for smelting and firing enamels.

Ceram. Ind., **9**, 678 (1927).

BUREAU OF STANDARDS PUBLISHES RÉSUMÉ OF CERAMIC INVESTIGATIONS.—A short review of the following investigations being made at the Bureau of Standards: (1) physico-chemical factors affecting the consistency of enamel slips, (2) effect of typical enamels on colors obtained with various stains, (3) effect of composition on the properties of ground-coat enamels, and (4) cast iron for enameling purposes.

Céramique, La, **14**, 204 (1911).

WHITE ENAMEL WITH ZIRCONIUM SILICATE BASE.—The use of pure ZrO_2 as a substitute for SnO_2 in white enamels is known but the former is more expensive and has less covering power than tin so attempts have been made to use the natural or normal silicate of zirconium. This proves to have much less value than the pure oxide as an opacifier but the extraction of part of the SiO_2 from the normal silicate gives a bulky product su-

perior to ZrO_2 or SnO_2 at less cost than either. The process consists in removing coloring impurities from pulverized silicate by digestion with hydrochloric acid and treatment with four parts of NaOH (or Na_2CO_3) at 500 to 600°. The alkali removes a sufficient amount of SiO_2 and being leached out with acidulated water leaves the desired product. (*Chem. Abs.*, **6**, 1665 (1912).)

Ceramist, **4**, 380 (1924).

CONTINUOUS CONVEYER ELECTRIC ENAMELING SERVICE.—A description of an electrically-operated furnace for enameling comparatively flat pieces is given. This furnace was developed by C. C. Armstrong of the Armstrong Manufacturing Co., Huntington, W. Va.

Ceramist, **5**, 279 (1925).

FUNDS SECURED FOR ENAMELING RESEARCH.—Appropriation for enameling research secured by the Enamel Division, AMERICAN CERAMIC SOCIETY. The official report by Mr. Staley, outlining the research program and a list of contributors to the fund are included in this article.

Ceramist, **6**, 629 (1925).

BUREAU OF STANDARDS, WORK ON GLASS AND ENAMELS.—A review of the progress of investigations. *Cast iron:* (Probable cause of blisters) (1) difference in operating conditions, (2) presence of some element not shown by ordinary analysis, (3) graphite on surface of casting which is not removed by sandblasting. Vitreous enamels for sheet iron and steel white ground coat have not been developed to work as successfully as the ordinary blue ground coat. Work on white cover enamels has been completed. Report of this investigation has been presented for publication. Principles underlying the properties of enamel suspension are given. Some of the preliminary work is discussed and experiments to be undertaken are outlined.

Ceramist, **7**, 81 (1925).

FREE QUARTZ IN FELDSPAR. (A Discussion.)—(1) H. D. PANTON states the assumptions made when the Watkins' formula is used for calculating free quartz from the chemical analysis and gives a more exact method which does not involve this assumption. (2) F. P. KNIGHT, JR., points out errors in a quotation in a previous paper by Malinovszky and also errors in the Watkins' method. He states there is no acceptable way to calculate free quartz content from an analysis of a feldspar except by norms. He compares the results of calculations based on the molecular numbers as given in Dr. Washington's tables with those given by Malinovszky in a previous paper. (3) MALINOVSZKY defends the methods and calculations, given in his paper, as being of practical use and says that his experience shows that the calculation of the coefficient of expansion of a feldspar by Staley's method is much more important than the calculation of the free quartz. (4) H. F. STALEY states there is no "Watkins' " method for calculating free quartz and states that the other methods given by Panton, Knight, and Malinovszky are essentially the same. He agrees with Malinovszky as to the greater importance of calculations of the coefficient of expansion. (*Ceram. Abs.*, **5**, 81 (1926).)

Ceramist, **8**, 38 (1926).

"REFRACTORY VALUE" OF ENAMELS. (A Discussion.)—Refractoriness must depend largely on composition. Determination of the "refractory value" of ground coats is an attempt to calculate the relative refractoriness of ground-coat enamels from their melted compositions by assigning certain factors to the various constituents. H. F. STALEY gives the factors and shows how the refractory value is obtained by dividing the

"units of refractoriness" by the "units of fusibility." In working with a wide variety of ground coats, it has been found that the best refractory value of those used for sanitary ware was about 2.80. The refractory value of a ground to be used in a certain class of work depends more upon the temperature of the furnace than on the class of work. M. E. MANSON questions the assignment of the value 3 to Al_2O_3, with SiO_2, as 1, because according to "flint equivalent" calculations Al_2O_3 has only 1.5 times the effect of SiO_2. He also questions the choice of 2.8 as the ideal refractory value. In his own furnace, operating at about 1800°F, a ground coat with a refractory value of 4.2 was superior to one having a value of 2.8. A. P. WOOLFOLK finds no discrepancies in applying Staley's method to his ground coat. R. C. BOYD finds the best refractory value for a ground coat to depend upon the temperature at which the enamel is fired. At low temperatures (1450°F) a refractory value of 2.2 gives satisfaction. He gives reasons for believing that the refractory value could be higher if the per cent of raw additions were lower. A. MALINOVSZKY, like Manson, questions the value 3 for Al_2O_3. He has used the value 1.7 for years, with good results. A ground coat of refractory value 2.76 has given good results. On mixing Staley's ground coat No. 4 (R. V. 2.81) it was found to work excellently in the range 1600 to 1700°F. H. F. STALEY says the factors 10 and 15 used in calculating the flint equivalent give no indication of the relative effect of SiO_2 and Al_2O_3, respectively, on refractoriness. One part of Al_2O_3 increases the refractoriness 3 times as much as one part of SiO_2. He shows how the factors 10 and 15 provide a simple empirical formula and do not contradict the above statement. The refractory value to be set up in a given plant will depend on the temperature at which the furnaces are operated as well as the percentage of raw additions. (*Ceram. Abs.*, **5**, 243 (1926); *Chem. Abs.*, **20**, 2901 (1926).)

Ceramist, **8**, 285 (1926).

BUREAU OF STANDARDS INVESTIGATIONS OF POTTERY, HEAVY CLAY PRODUCTS, GLASS, AND ENAMELS.—A summary of the activities and accomplishments of the Bureau of Standards in the field of ceramics since August, 1925; the following are listed under the enamel work: (1) effect of typical enamels on colors obtained with various stains, (2) cast iron for enameling purposes, (3) investigation of the field of ground-coat and white-cover enamels for sheet iron and steel, and (4) physico-chemical factors affecting the properties of enamel suspensions. (*Ceram. Abs.*, **5**, 377 (1926); *Enamelist*, **3** [6], 6 (1926); *Chem. Met. Eng.*, **33**, 167 (1926).)

***Challenge Refrigerator Co.**

BONUS SYSTEM BOOSTS PRODUCTION. See *Ceram. Ind.* (this *Bibliography*, p. 56).

***Chamberlain**

ENAMELING CAST-IRON BATHS. See Spon (this *Bibliography*, p. 285).

***Chapin, H. M.**

See *Jour. Amer. Ceram. Soc.*, Ref. books on enamels (this *Bibliography*, p. 166).

***Chappell, E. L.**

PRACTICAL APPLICATION OF INHIBITORS IN PICKLING OPERATIONS. See Speller, F. N. (this *Bibliography*, p. 284).

***Chapuy, P.**

COLORATION OF PORCELAIN ENAMELS. See Le Chatelier, A. (this *Bibliography*, p. 197).

Chatley, Herbert

MOLECULAR FORCE AND PLASTICITY OF CLAYS. *Trans. Ceram. Soc.* [Eng.], **19,** 1-2 (1919-20).—Suggestion is made that plasticity (and also, when the molecules of the fluid are considered, the specific "colloid" properties of subdivided matter) is due to the presence of molecular forces comparable with weight or other external agency. (*Ceram. Abs.*, **1,** 7 (1922).)

***Chattanooga Stamping and Enameling Co.**

ENAMELING PLANT AT CHATTANOOGA, TENN. See Poste, E. P. (this *Bibliography*, p. 237).

Chem. and Ind., **33,** 179.

OLDEST ENAMEL COLOR WORKS IN GERMANY.—(Historical.) The factory of Geitner & Co. was 100 years old, April 1, 1910. (*Chem. Abs.*, **5,** 168 (1911).)

Chem. and Ind., **39B,** 271 (1920).

TITANIUM IN ENAMELS.—The advantages of rutile outweigh the disadvantages. Enamels containing rutile are more resistant to corrosion, have a higher gloss, and greater resistance to abrasion. The greatest disadvantage is the maintenance of a satisfactory state of suspension of titanium oxide in the frit.

Chem. and Ind., **45,** 943 (1926).

CAST-IRON RESEARCH.—(Fifth annual report of the British Cast-Iron Research Assn., J. G. Pearce, director.) Research is conducted in the Association's own laboratory at Birmingham, in several university laboratories, in the National Phys. Lab., and at the works of several members of the Association. More than £6000 were spent on research in 1925. Among the subjects investigated were: (*a*) cupola mixtures resisting corrosion more than ordinary gray iron, and yet capable of being machined and possessing good mechanical properties; (*b*) formation of graphite in a synthetic cast iron so as to control the size and distribution of the particles of graphite; (*c*) production and treatment of malleable cast iron. (*Ceram. Abs.*, **6,** 95 (1927).)

Chem. and Ind., **46,** 209 (1927).

FERROUS METALLURGY AND CORROSION.—To all industries using metal in any form, the recent advances in metallurgical knowledge constitute an important advantage, and chemical engineers benefit by them. The new steels are divided into three groups: (1) those containing high Ni and low Cr, (2) those containing low Ni and high Cr, and (3) those comparatively high in both Ni and Cr. The first group is resistant to acids other than HNO_3 and to salts, especially when containing a few per cent of Mo. The second group is immune to HNO_3 and to contaminated atmospheres. The third group gives general resistance at high temperatures. (*Ceram. Abs.*, **6,** 213 (1927).)

Chem. Met. Eng., **22,** 810 (1915).

ENAMEL INVESTIGATIONS AT THE BUREAU OF STANDARDS.—At the request of the Metalware Manufacturer's Association of America, the Enameled Metal Division of the AMERICAN CERAMIC SOCIETY, and a large number of individual manufacturers, the Bureau of Standards is carrying on a comprehensive research in an endeavor to discover the cause or causes of the jumping off of small particles of enamel, which results in fishscaling, and the methods of controlling and eliminating it. This investigation, begun in July, 1919, has been conducted energetically ever since. The Bureau has also had in progress an investigation of the relation of composition of enamel to solubility in strong mineral acids. Results so far obtained indicate that some of the commonly ac-

cepted conceptions of the relation between composition and acid resistance of enamels are erroneous. Information is being secured, also, in regard to relations of composition to fusibility and to the tendency to chip, craze, or crack. (*Jour. Amer. Ceram. Soc.* (Abs.), **3,** 600 (1920).)

Chem. Met. Eng., **22,** 1107 (1915).

PAPERS ON ENAMELING, CHICAGO SECTION, AMERICAN CERAMIC SOCIETY. (Staff Article).[1]—The following papers are mentioned in the report of the Secretary of the Section: "The Enameling of Cast Iron," by L. H. Menne and "The Preparation of Steel for Enameling," L. G. Whitford. (*Jour. Amer. Ceram. Soc.* (Abs.), **3,** 600 (1920).)

Chem. Met. Eng., **25,** 206 (1918).

ELECTRIC VITREOUS ENAMELING FURNACE.[2]—The following advantages were secured by substituting electric heating for oil heating: (1) reduction of rejections from 25% to practically zero, (2) increase of 50% in output without increase of floor space, (3) fuel saving of 47.4%, (4) improved quality, (5) higher degree of uniformity, (6) fewer furnace repairs and lower cost for maintenance, (7) greater ease of operation, (8) furnace heated up more quickly by elimination of muffle. A two-compartment open-chamber furnace with separating door operated from the outside is described. The source of heat is an electric current passed through nichrome resistor ribbon wound over refractory supports arranged along the sides of the furnace. The front or preheating compartment is operated at 300°C and the back or finishing compartment at 900°C, with automatic control. (*Jour. Amer. Ceram. Soc.* (Abs.), **4,** 946 (1921).)

Chem. Met. Eng., **27,** 510 (1922).

GROWTH OF CAST IRON.[3]—Growth of cast iron in heating is attributed to two different causes: (1) internal oxidation and (2) expansion of occluded gases. K. measured the leakage of gases through a gray cast-iron tube at room temperature and at 960°C. Leakage at high temperature was only slightly less. It is therefore improbable that air enters at low temperatures and cannot escape at high temperatures. Tests *in vacuo* show that growth is not due to oxidation. K. concludes that growth is due to decomposition of cementite and to formation of minute fissures, caused by differential expansion of various microportions. (*Ceram. Abs.*, **2,** 31 (1923).)

Chem. Trade J. and Chem. Eng., **77,** 356 (1925).

ANTIMONY OXIDE.—Investigations have been made by Wohlgemuth and Rewald into the use of antimony oxide in the enameling industry, where it has largely replaced tin oxide in recent years. Experiments on various frits made from a commercial oxide free from arsenic, lead, barium, and zinc, led them to the conclusion that such an oxide is absolutely innocuous even when forming part of glazes on cooking utensils. (*Ceram. Abs.*, **5,** 268 (1926).)

Cheney, Merritt B.

LIMITS OF COMPOSITION OF ENAMELS FOR CAST IRON. *Trans. Amer. Ceram. Soc.*, **12,** 543 (1910).—The following limits of composition for a ground coat for cast iron were found:

$$\left.\begin{matrix}0.40\text{–}0.50\ K_2O \\ 0.50\text{–}0.60\ Na_2O\end{matrix}\right\} 0.55\text{–}0.63\ Al_2O_3 \left\{\begin{matrix}1.5\text{–}2.0\ B_2O_3 \\ 2.75\text{–}3.25\ SiO_2\end{matrix}\right.$$

(*Chem. Abs.*, **5,** 362 (1911).)

[1] See *Jour. Amer. Ceram. Soc.*, **3,** 522 (1920).

[2] See L. E. Barringer, *ibid.*, **4,** 461 (1921).

[3] From report by Tario Kikuta, *Jap. Iron and Steel Inst.*

Chevenard, P., and Portevin, A.

DILATOMETRIC ANALYSIS OF CAST IRON. *Rev. Metal.*, **22**, 357 (1925).—Determinations were made by differential dilatometer over the range 0 to 1100° using the nickel-chromium-tungsten alloy Pyros as standard. Swedish iron showed a marked change in dilatation coefficient in the region of the magnetic transformation (770°), and a sharp contraction during the α-γ transformation, this contraction being less as the impurities in the iron increased. Cementite, isolated, showed a reversed change in dilatation value, coinciding with the magnetic transference point; a similar point of inflection was indicated by all ferro-magnetic alloys, such as α iron, magnetite, and ferro-metals. It is considered that the term "double carbide" should be replaced by "cementite complex," as it has been proved that Mn_3C forms a solid solution with Fe_3C. (*Ceram. Abs.*, **5**, 12 (1926); *Chem. and Ind.*, **44B** (1925).)

***Chicago Hardware Foundry Co.**

A LABORATORY CONTROLLED ENAMEL PLANT. See *Ceram. Ind.* (this *Bibliography*, p. 58).

***Chicago Vitreous Enamel Products Co.**

ROTARY SPRAYING BOOTH TURNS OUT 720 AVERAGE PIECES OF ENAMELWARE HOURLY. See *Ceram. Ind.* (this *Bibliography*, p. 52).

Chow, M. C.

RESEARCH ON ENAMEL RAW MATERIALS. *Jour. China Soc. Chem. Ind.*, **3**, 9.—Analyses given. (*Ceram. Abs.*, **4**, 299 (1925); *Chem. Abs.*, **19**, 2732 (1925).)

***Christman, H. M.**

PRACTICAL ENAMEL SMELTER LINING. See Prentice, E. B. (this *Bibliography*, p. 250).

Clark

ENAMEL ON CAST-IRON APPARATUS. *Lond. J. C. S. V.*, **17**, 97; *Rept. of p. es.*, **5**, 98; *Dingler's poly. J.*, **79**, 111. (*Rept. der Tech. Lit.*, p. 272 (1823–1853).)

Clark, A. M.

STEEL FOR ENAMELING. British Pat. 10,790, May 23, 1899.—By this process, steel or iron is brought into a condition specially adapted for receiving and retaining a coat of enamel. The process consists in adding to the molten metal one or more of the enamel fluxes, similar or analogous to the fluxes intended to be used in subsequent enameling. Steel or iron so treated can be cast, rolled, or otherwise worked into any desired shape. (*Chem. and Ind.*, **18**, 1130 (1899).)

Clark, C. F.

PREPARATION OR MANUFACTURE OF ENAMELED IRON AND STEEL PLATES, HAVING LETTERS, ETC., APPEARING ON SURFACE. British Pat. 4853, Mar. 18, 1891.—Hitherto letters, designs, etc., have been produced on iron and steel plates by first coating the whole surface with a colored opaque enamel, and then forming the letters or designs of another enamel on the surface of the first enamel. Another method was to form the letters in opaque enamel on the surface of the metal plate and then to coat the general surface nearly or quite to the level of the raised letters. In this invention letters or designs sunk in the metal plate are filled with opaque enamel, and after firing a transparent or semitransparent enamel is spread over the surface of the plate, and also over the opaque enamel. (*Chem. and Ind.*, **11**, 434 (1892).)

Clark, H. H.

METHOD OF FURNACE OPERATION. U. S. Pat. 1,507,664–5, Sept. 9, 1924.—(1) An enameling furnace is heated to a desired temperature, heating is discontinued,

and the articles to be enameled are placed in the furnace, the sensible heat of which completes the process. Contamination of the ware with furnace gases is thus avoided. (2) The method can be applied to a number of other processes. (*Chem. and Ind.*, **43B**, 1014 (1924).)

Clark, H. H.

GAS-FIRED ENAMELING FURNACES: COMPARATIVE RESULTS OF INTERMITTENT, SEMIMUFFLE, AND FULL MUFFLE TYPES. *Bull. Amer. Ceram. Soc.*, **5**, 423 (1926).—This 4 x 10 furnace equipped with full muffle, used 10% more gas for the same production. This is due to the necessity of having a higher temperature in the flue gases in order to keep the same working temperature. The intermittent furnace is of greatest value in a shop where there is a large variety of work to be done, such as color work, sheet steel, and cast iron. With gas fuel and a well-designed furnace, there is no need for the full muffle.

Size	Type	Heats (per hr.)	Ware (sq. ft.)	Gas (cu. ft.)
4 x 10	Intermittent	10	200	1640
4 x 10	Semimuffle	15	300	1200
* 4 x 10	Semimuffle	22	440	1200

* Equipped with speed fork.

Clark, H. H.

NEW TYPE OF GAS-FIRED VITREOUS ENAMELING FURNACE. *Jour. Amer. Ceram. Soc.*, **5**, 478 (1922).—This furnace has a working chamber 4 ft. wide, 3 ft. high, and 10 ft. long and is heated by 10 gas burners, 5 on each side. Other proportions are made to suit the nature of the work to be enameled. City gas is most desirable, although any gas above the grade of producer gas may be used. A furnace of this type can be brought to a working temperature in less than an hour and will turn out from 12 to 24 loads of work an hour, depending on the kind of work being enameled. The average gas consumption is about 1800 cu. ft. of 500 B.t.u. gas per hour when firing about 600 sq. ft of flatware totalling 690 pounds, representing 240 pieces, at an average temperature of 1700°F. The furnace runs without attention other than that given by the men who load and unload the fork. Furnaces of the intermittent type have various features which are covered by patents issued and applied for. In addition to fuel economy, this type of furnace has the added advantage of producing ware of a very high gloss. The first cost is low and no foundations other than the ordinary cement floor are necessary, as the entire surface is above the floor level. Maintenance is practically nothing, as there is no muffle or combustion chamber. Discussion of this paper, *Bull. Amer. Ceram. Soc.*, **1**, 238 (1922). (*Chem. Abs.*, **16**, 3188 (1922); *Chem. and Ind.*, **41A**, 710 (1922).)

Clark, H. H.

GAS AS FUEL FOR VITREOUS ENAMELING. *Jour. Amer. Ceram. Soc.*, **7**, 643 (1924).—The typical furnace described has a firing chamber 4 feet wide, 10 feet long, 34 inches high, no muffle being necessary. The furnace is of the intermittent type. All the details of normal production are given together with a résumé of the surprisingly low total cost per hour. A comparison of the average hourly production on 24- and 22-hour bases is given. Also several suggestions are made that will materially effect additional economies in the use of gas for vitreous enameling. The 24-hour basis is the average work produced per hour in a 24-hour period, just as the furnace was operated. The 22-hour basis is the amount of work actually produced per hour of production, as the furnace was in operation 24 hours per day, but in actual operation only 22 hours per day. Points for additional reduction in cost: (1) extend production period to 24 hours; (2) have men firing enamel use all of their time to that operation; ware should be trucked to

Average Hourly Production Sq. ft. of ware enameled	18 Gage	20 Gage
24-hr. basis	384	412
22-hr. basis	418	450

Average Hourly Production Lbs. of ware enameled	18 Gage	20 Gage
24-hr. basis	626	721
22-hr. basis	682	787

Average Cost of 100 Sq. Ft. of Ware Enameled	18 Gage	20 Gage
24-hr. basis	$0.37	$0.35
22-hr. basis	.34	.32

Average Cost of 100 Lbs. of Ware Enameled		
24-hr. basis	$0.23	$0.20
22-hr. basis	.21	.18

and from them; (3) use longer runs on the same class of ware; (4) utilize waste heat; (5) increase in business gives lower gas rate. (*Chem. Abs.*, **18**, 3263 (1924).)

Clark, H. H.

GAS-FIRED ENAMELING FURNACES WITHOUT MUFFLES. *Jour. Amer. Ceram. Soc.*, **8**, 623 (1925).—First attempts to design enameling furnaces reveal unsuccessful results to increase efficiencies. The early attempts to eliminate the undesirable feature of coal-fired furnaces resulted in building furnaces having high thermal heads and uneven heat distribution which were costly to maintain. The intermittent type of enameling furnace was developed with the possible disadvantage that speed forks cannot be used. An example of the installation of a semimuffle gas-fired enameling furnace in the plant of the Cribben & Sexton Co., Chicago, is cited. Its principal feature is constant atmospheric conditions accomplished by high-pressure gas burners. The design, details, performance data, and operating costs are given. A résumé stating the many advantages of gas are appended.

DATA ON THE BASIS OF FOUR MONTHS' OPERATION

1222 cu. ft. gas at 72¢ per 1000 cu. ft.	$0.88
Gas compression expense (power, water, labor)	.03
Maintenance	.02
Interest, depreciation, taxes (furnace)	.14
Av. production per hr. sq. ft. of ware enameled = 531	$1.07
Cost per 100 sq. ft. of ware enameled = $1.07/531 = $0.20.	

(*Enamelist*, **2** [5], 6 (1925); *Chem. Abs.*, **19**, 3575 (1925).)

***Clark, H. H.**

VISCOSITY OF CLAY SLIPS DETERMINED BY THE CLARK APPARATUS. See Bleininger, A. V. (this *Bibliography*, p. 27).

Clark, T., and C., and Co.

ENAMELING CAST-IRON PIPES AND CYLINDERS. British Pat. 239,598, June 12, 1924. (*Chem. and Ind.*, **44B**, 882 (1925).)

Clark, T., and C.

MANUFACTURE OF ENAMELED IRON PIPES AND CYLINDERS. British Pat. 239,908, June 12, 1924. (*Chem. and Ind.*, **44B**, 882 (1925).)

Claus, B. and H.

ENAMELS FOR IRON PLATES, ETC. *Zeit.*, **55**, 34 (1896).—The enamel consists of 130 parts of feldspar, with 125 borax, 70 quartz, 25 soda, 17 niter, 10 fluorspar, 4 an-

timony, and 0.5 cobalt. The large proportion of feldspar makes the enamel less fusible, but it adds to its covering power and to its resistance to chemical action. (*Chem. and Ind.*, **16**, 144 (1897).)

Claus, H.

MACHINE FOR BRUSHING ENAMEL OFF PLATES. U. S. Pat. 465,462, Dec. 22, 1891.—The combination, with a table adapted, to hold the articles to be brushed, of the brush, its brush-frame, joint, rod, universal joint, swivel frame, main shaft, and mechanism for imparting rotary motion to the brush from the shaft.

Claus, H.

IMPROVEMENTS RELATING TO THE ENAMELING OF IRON PLATE. British Pat. 22,705, Dec. 29, 1891.—In order to enamel iron-plate utensils in imitation of granite or in mottled or variegated colors, and with a rough surface, the articles undergo three treatments. They are coated first with an enameled ground and then washed with a solution of magnesium and ammonium sulphates, which serves to decompose the next enamel coating. This second enamel is very coarsely ground to produce roughness. A thin paste of transparent enamel as finely ground as possible is finally applied. (*Chem. and Ind.*, **11**, 435 (1892).)

Claus, H.

IMPROVEMENTS IN PRODUCTION OF ENAMELED IRONWARE. British Pat. 22,732, Dec. 29, 1891.—In order to obtain mottled enameled ware in gray, blue, or white marbling or other tints one or two processes may be used; the iron either receives a single thick coating or two or more thin coatings. For the former process, the enamels are such that the metallic groundwork may be partially oxidized and speckles produced in the enamel. The alkaline ingredients are reduced so as to obtain a completely glazed hard mass after melting down. In the second process the ground enamel is of elastic soft composition, and may be mixed with nickel or cobalt oxide; it should be applied in a very thin layer. The covering material consists of finely powdered feldspar, granite, sand, cryolite, borax, saltpeter, kaolin, and tin oxide; when these are ground to a mass some nickel sulphate and cobalt sulphate are added. The mixture is then applied in thin layer, and while still moist is powdered over with some ammonia soda, dried, and fired as usual. The glaze is said to be beautifully tinted. C. explains the reaction as due to the formation of $NiCO_3$ and $CoCO_3$ on addition of the soda; these substances tend to draw out and absorb the dissolved $NiSO_4$ and $CoSO_4$ to form basic salts, $2CoCO_3 + 3Co(OH)_2$, or $2NiCO_3 + 3Ni(OH)_2$; thus the coloring matter is concentrated at central points. On the addition of soda, sodium sulphate is formed; this quickly takes up water of crystallization causing currents in the enamel and producing beautiful designs. These enamels are of great durability and resist acid. For the resistance of strong chemical reagents a thin covering of feldspar, fluorspar, quartz, borax, and saltpeter is applied. Salts of copper, chromium, iron, and manganese may be used. (*Chem. and Ind.*, **11**, 435 (1892).)

Claus, H.

ENAMEL FOR METAL ARTICLES. U. S. Pat. 485,574, Nov. 1, 1892.—A glaze or enamel for metal articles, having its surface covered with groups of spots that are lighter in the middle than at their margin, the groups being separated by blank spaces, having clouds, substantially as and for the purpose shown.

Claus, H.

ENAMELING METALWARE. U. S. Pat. 506,390, Oct. 10, 1893.—The process described of enameling metallic articles, which consists in first coating the vessel with a

ground enamel containing sulphate of ammonia, and in applying to the ground while still moist an alkaline enamel consisting of feldspar, quartz, cryolite, soda, oxide of tin, and saltpeter.

Claus, H.

IMPROVEMENTS IN THE MANUFACTURE OF ENAMELED GOODS. British Pat. 20,817, Nov. 2, 1893.—In the methods formerly employed the spotting and marking of the metallic surface were obtained by oxidation of the steel or iron by the action of the acid in the enamel, such enamel consisting of silicate, borax, gypsum, and soda. This enamel requires very careful drying in a separate drying room, and the markings produced depend on the structure of the metal, a homogeneous material failing to give the variegated appearance which is desired. In this invention an enamel of the following composition is employed: feldspar, 130; borax, 125; quartz, 70; soda, 25; saltpeter, 17; fluorspar, 10; antimony, 4 parts; cobalt, $^1/_2$ part. The metallic surface, having been covered with the enamel, a mixture of equal parts of blue vitriol and green vitriol is powdered over the surface of the enamel. The whole is air-dried and then fired; the salts of copper and of iron descend through the enamel to the metal plate. Oxidation takes place at the surface of the metal through the action of the alkaline enamel upon the metallic salts, and the spotting is produced. The spotting thus produced is independent of the structure of the metal, but can be varied at will by using larger or smaller grains of the metallic salts. An additional advantage gained by the process is that careful drying in a separate drying room is not necessary. (*Chem. and Ind.*, **13**, 39 (1894).)

Claus, H.

ENAMELING METALWARE. U. S. Pat. 527,361, Oct. 9, 1894.—The process of enameling which consists in coating an article with an alkaline enamel and in applying thereto, while still moist, sulphate of iron, sulphate of copper and supermanganate of potassium.

Claus, Herbert

ENAMEL MACHINE. U. S. Pat. 721,155, Feb. 24, 1903.—An enameling machine comprising a rotary carrier, an article holder mounted to revolve therewith and also capable of a rotary movement relatively to the carrier about an axis perpendicular to that of the carrier, a device arranged to apply enamel to the article as it is carried around by the holder, means operated by the rotary movement of the carrier for rotating the holder relatively to the carrier while the article has its coat of enamel, and means for releasing the article from the holder.

Cliff

GLAZING IN OVENS WHICH ARE HEATED WITH GAS.

Lond. J. N. S., **17**, 97; *Ctrlbl.*, p. 554 (1863); *Génie civil*, **28**, p. 284. (*Rept. der Tech. Lit.*, p. 306 (1854–1868).)

***Clifford, John**

ENAMELING TABLE OR MACHINE. See Hoelscher, Edward, Co. (this *Bibliography*, p. 155).

Cochran, James

ENAMELING METAL. U. S. Pat. 533,945, Feb. 12, 1895.—In the art of enameling metallic articles to which enamel will not readily adhere, the process which consists in first placing upon such metallic article a coating of another metal and an acid which is capable of permeating the coating and oxidizing the body of the article, the resulting

oxide in turn permeating the metal coating, and in applying an enamel to the surface of the coating.

Cockburn, M., and Co. (Falkirk, Scotland).

See Estep, H. C. (this *Bibliography*, p. 114).

Coe, John H.

COMPARISON OF COMMERCIAL GROUND COATS FOR CAST-IRON ENAMELS. *Trans. Amer. Ceram. Soc.*, **13**, 531 (1911).—The conclusions are as follows: (1) The use of cobalt oxide in ground for cast-iron enamels is of doubtful value. (2) Clay is a poor material to use in a frit and is not as desirable as a raw material from the standpoint of heat range as is feldspar or flint. (3) There is no special advantage in respect to heat range, in making blends of materials which are to be used raw. (4) There is a decided advantage in blending frits as the heat range is materially extended. Feldspar, flint, and clay are interchangeable without changing the fusion in the following ratio of parts by weight: 100 feldspar, 65 flint, 40 clay.

GENERAL OUTLINE OF INVESTIGATION

Classes	Groups	Series	Sub-Series
(A) All fritted	I Without cobalt	(*a*) Single glasses	(1) Flint glass
			(2) Feldspar glass
			(3) Clay glass
		(*b*) Blend of glasses	(1) Blends of 2 glasses
			(2) Blends of 3 glasses
	II With 1% cobalt oxide	Same as above	Same as above
(B) Part fritted Part raw	I One frit, one raw material	(*a*) Flint frit	(1) Raw feldspar
		(*b*) Feldspar frit	(2) Raw flint
		(*c*) Clay frit	(3) Raw clay
	II One frit, blends of raw material	(*a*) Flint frit	(1) Blends of 2 raw materials
		(*b*) Feldspar frit	(2) Blends of 3 raw materials
		(*c*) Clay frit	
	III Blended frits, one raw material	(*a*) Raw feldspar	(1) Blends of 2 frits
		(*b*) Raw flint	(2) Blends of 3 frits
		(*c*) Raw clay	
(C) All raw			(1) Refractory material (feldspar)
			(2) Refractory material (flint)

(*Chem. Abs.*, **5**, 3892 (1911); *Chem. and Ind.*, **30**, 1386 (1911).)

Coethen

TRAINING ENGINEERS FOR ENAMEL WORKS AT FRIEDRICH-POLYTECHNICUM. *Glashütte*, **41**, 309(1911). (*Chem. Abs.*, **5**, 2711 (1911).)

Colin, G., et Cie

PROCESS OF ENAMELING CAST-IRON ARTICLES (POTS AND COOKING UTENSILS). French Pat. 411,630, April 14, 1909; British Pat. 17,270, July 28, 1911.—The interior of the pots is polished and then oxidized into a layer of magnetic oxide of iron, to which the enamel is applied by the wet process and as liquid as possible. (*Chem. and Ind.*, **29**, 951 (1910); *ibid.*, **31**, 130 (1912); *Chem. Abs.*, **7**, 407 (1913).)

Collins, E. F.

VITREOUS ENAMELING WITH ELECTRIC FURNACE. *Fuels and Fur.*, **2**, 1273 (1924).—The advantages claimed are: (1) no contamination by gases of combustion, (2) a

minimum of defective ware, (3) a saving of floor space, (4) uniformity in quality, (5) possibility of using a conveyer type of furnace, (6) rapid heating, easily controlled, (7) good edges on the ware, (8) good working conditions, and (9) securing a vitreous coat that is adhesive and true to color. (*Ceram. Abs.*, **4**, 99 (1925); *Chem. Abs.*, **19**, 566 (1925).)

Collins, E. F.

VITREOUS ENAMELING WITH ELECTRIC HEAT. *Jour. Amer. Ceram. Soc.*, **6**, 794 (1923).—The suitability of the metallic resistor furnace for the application of vitreous enamels is described. Comparisons are made with fuel-fired furnaces. Uniformity and perfect fusion of enamel results from the high grade temperature control of the electric furnace. Atmospheres vitiated with products of combustion cannot be present in the electric furnace to give defective coatings. Examples of operating furnaces for watch dials and for bathtubs are given and the average performance in time and input for bathtub furnaces. It is believed by C. that the electric heating process cannot long be considered as anything but the most economical over all and its standardization for this purpose will eventually result. (*Chem. Abs.*, **17**, 3765 (1923).)

Collins, W. D.

ACID TEST ON ENAMELWARE. *Ind. Eng. Chem.*, **14**, 8 (1919).—Tests were made at the U. S. Bureau of Agriculture for acid resistance of 6-inch samples of enameled kitchenware from twenty-six American manufacturers. The principal test consisted of boiling 500 cc. 4% acetic acid in the vessel for one-half hour. Some tests were also made with 1% tartaric and citric acids, the results of which corresponded to those obtained with 4% acetic acid. About one-half of the samples of white- and grayware suffered no loss of "glaze" on treatment with 4% acetic acid, while nearly all blueware was badly affected with 2% acetic acid. The amount of material dissolved in each case corresponded with the loss in "glaze." Seventeen samples from nine manufacturers gave no test for antimony. White and gray enamels contained about equal amounts of antimony according to tests, 34 out of 47 samples giving up 0.5 to 2.0 mg. of antimony when boiled with 4% acetic acid for 6 hours. Tests showed no antimony present in four blue enamels tested. Lead was found in ware from only one manufacturer. Pieces of enamel chipped off several vessels under a heat treatment no more severe than might be received by any cooking vessel in use. (*Jour Amer. Ceram. Soc.* (Abs.), **2**, 843 (1919); *Chem. Abs.*, **13**, 2266 (1919); *Chem. and Ind.*, **38A**, 903 (1919).)

***Columbian Enameling & Stamping Co.**

UNIQUE PICKLING SYSTEM HUMIDITY DRIERS. See *Ceram. Ind.* (this *Bibliography*, p. 53).

Comstock, C.

ENAMELING. U. S. Pat. 592,724, Oct. 26, 1897.—The process which consists in first coating a surface with enamel or analogous material, then applying to such surface a solution of metallic salt to produce a color in the enamel and finally subjecting the surface so treated to heat to vitrify the coating and develop and fix the color.

Comstock, George F.

CAUSES OF BLISTERING OF SHEET-STEEL METAL ENAMELS. *Jour. Amer. Ceram. Soc.*, **6**, 873 (1923).—The results are given of a metallographic investigation of some samples of defective white enamelware, the peculiarities of the steel underlying the defects having been examined through the microscope. Two distinct kinds of defects were recognized, one of which, characterized by dark spots arranged in streaks, was found to be due to foreign inclusions in the steel. It was concluded that the other de-

fect consisting of irregularly scattered spots, was most probably due to gas absorption during pickling, the ultimate cause lying either with the pickling process or the steel quality. Detailed descriptions and photomicrographs are given of the structures and inclusions in the steel bases of the samples examined. (*Chem. Abs.*, **17,** 3765 (1923); *Chem. and Ind.*, **42A,** 1023 (1923).)

Cook, F. D.

CONTINUOUSLY MELTING VITREOUS ENAMELS. U. S. Pat. 1,460,888, July 3, 1923.—The melting chamber used is of such a form that accumulation of the molten enamel is prevented, the molten material running continuously from the chamber as it is formed. The temperature of the enamel, during withdrawal and previous to quenching, is controlled. (*Chem. and Ind.*, **42A,** 832 (1923); *Chem. Abs.*, **17,** 2943 (1923).)

Cook, H. L.

EFFECTS OF VARIOUS ELECTROLYTES WHEN ADDED TO ENAMEL SUSPENSIONS MADE WITH AND WITHOUT CLAY. *Jour. Amer. Ceram. Soc.*, **10,** 344 (1927).—The literature is reviewed. The effects of various electrolytes on a clay slip, an enamel slip, a finely-ground clay-sand-water suspension, and a finely-ground sand-water suspension were observed. "Setting-up" of water suspensions of finely-divided insoluble materials seems more dependent on fineness of grinding and degree of solution of the suspended material than upon the presence of clay. (*Ceram. Abs.*, **6,** 264 (1927); *Chem. Abs.*, **21,** 2774 (1927); *Chem. and Ind.*, **46B,** 630 (1927).)

Cook, H. L.

SOLUBILITY OF ENAMEL FRIT IN MILL WATER. *Jour. Amer. Ceram. Soc.*, **10,** 339 (1927).—Methods of determining the solubility of enamel frit in mill water are outlined. Various tests show that (1) solution increases as fineness increases, (2) mixing has little or no effect upon solubility, (3) variations of smelter treatment have little or no effect upon solubility, and (4) Na_2O and B_2O_3 will dissolve from a dry ground frit proportionately to the fineness thereof. (*Ceram. Abs.*, **6,** 264 (1927); *Chem. Abs.*, **21,** 2775 (1927); *Chem. and Ind.*, **46B,** 630 (1927).)

Cooke, R. D.

REMOVING ENAMEL FROM METAL SURFACES. U. S. Pat. 1,272,917, July 16, 1918.—The enamel is rendered porous by an acid solution and then loosened by an alkali; *e. g.*, the articles are treated with 10% hydrochloric acid heated to 160° and then with 25% sodium hydroxide at 160°. (*Chem. Abs.*, **12,** 1917 (1918); *Chem. and Ind.*, **37A,** 591 (1918).)

Cooke, R. D.

ENAMELING SHEET METALWARE. U. S. Pat. 1,316,018, Sept. 16, 1919.—Sheet steel is coated with oil and subjected to a drawing operation; the ware is heated to remove the oil which produces a thin oxide coating on the metal, the enamel is then applied and baked. (*Chem. Abs.*, **13,** 2986 (1919); *Chem. and Ind.*, **38A,** 820 (1919).)

Cooke, R. D.

EFFICIENCY OF WET-GRINDING ENAMELS IN BALL MILLS. *Ceram. Ind.*, **6,** 183 (1926).—Wet-grinding enamel in pebble mills was studied. The variable factors considered were (1) speed of rotation of the mill, (2) proportion of water to total charge, (3) size of charge, (4) quantity of pebbles, and (5) [as a corollary of (3) and (4)] the ratio of size of charge to quantity of pebbles. Each of these factors was varied independently of the others and the effects noted upon power consumption, grinding time, and the labor per 1000 lbs. of enamel produced. The mill used was 54 inches in diameter

and 47 inches long. The lining was of silex blocks, 3 inches thick. Power was furnished by a 7½ H.P., 220 volt, d. c. motor, through a variable speed cone pulley, and suitable reducing pulleys. All frit was ground to the same degree of fineness. Standard conditions were pebbles, 1500 lbs.; frit, 1000 lbs.; water, 437.5 lbs.; other additions, 115 lbs.; and speed, 30 r.p.m. With these conditions the running time was 10.28 hours, the average power was 4.29 H.P. (elec.), and the labor of loading and discharging was 3 man-hours. The following table shows the condition which was varied, and the results, based on 1000 lbs. of enamel:

Variable	Mill hrs. per 1000	Kw.-hrs. per 1000	Man-hrs. per 1000
None	7.28	21.2	1.93
20 r.p.m.	12.55	23.5	1.93
40 r.p.m.	5.80	21.8	1.93
40% less enamel	4.94	16.1	2.36
40% more enamel	14.21	33.2	1.75
10% less water	10.00	26.0	1.93
10% more water	6.62	18.0	1.93
20% more pebbles	6.03	18.9	1.93
20% less pebbles	9.82	23.5	1.93

The ratio of pebbles to enamel was then kept constant and the total bulk of charge varied. The weight of pebbles was 1.4 times the weight of enamel and water. The following table gives the results:

Charge, lbs.	Mill-hrs. per 1000	Kw.-hrs. per 1000	Man-hrs. per 1000
2230	5.66	18.1	2.36
2486	5.56	17.9	2.25
3000	5.05	18.1	2.09
3600	4.98	17.5	1.96
4285	4.85	18.2	1.85

From these results it seems that power required per 1000 lbs. is independent of the size of the charge. (*Ceram. Abs.*, **5**, 116 (1926).)

Cooke, R. D.

A USEFUL MICROSCOPE ACCESSORY. *Enamelist*, **2** [2], 5 (1924).—Description of instruments made to hold small chips of enamel under microscope, the observer being able to view from different angles by rotating the specimen.

Cooke, R. D.

A FINENESS TEST FOR PEBBLE MILL CONTROL. *Enamelist*, **2** [4], 11–14 (1925).—Fifty grams of the enamel slip are weighed and washed into a 100-cc. glass-stoppered, graduated cylinder. An excess of sodium silicate is added and the whole made up to 100 cc. with water. The contents are thoroughly mixed by shaking a few seconds, the cylinder is placed upright and allowed to stand exactly one minute. The frit particles settle freely at this dilution at a rate depending on their size and form a distinct layer at the bottom of the cylinder. The number of cubic centimeters at the end of one minute (or any other time that may be more convenient) is an index of the fineness of the enamel. The clay remains suspended.

Cooke, R. D.

EFFECT OF FURNACE ATMOSPHERE ON THE FIRING OF ENAMEL. *Jour. Amer. Ceram. Soc.*, **7**, 277 (1924).—It is shown that in firing ground coat and other one-coat enamels, the atmosphere of the furnace plays an important part. Oxygen in the muffle penetrates the enamel during the early stages of the firing forming a film of iron oxide on the surface of the steel. This film, whether applied before enameling or formed incidentally to firing, partially dissolves in the fused enamel giving the intimate bond be-

tween metal and enamel. Ground-coat enamel fired in an atmosphere of nitrogen was found not to adhere to the steel. Approximate values are given for proportion of furnace space to enameled surface to insure sufficient oxidation when residual air is depended upon to supply the oxygen. (*Chem. Abs.*, **18,** 2589 (1924); *Chem. and Ind.*, **43B,** 514 (1924).)

Cooke, R. D.

PLASTIC PROPERTIES OF ENAMEL SLIP. *Jour. Amer. Ceram. Soc.*, **7,** 651 (1924).—A simplification of the Bingham plastometer, applicable to enamel slips, is described and the theory of plasticity discussed briefly. It was found that increase in temperature or increase in water content of enamel slips raised the mobility without greatly affecting the yield value. Addition of clay and certain inorganic salts raised the yield value without changing the mobility. Sodium silicate reduced the yield value to zero and lowered the mobility. The yield value is that property of enamel which causes it to hold its form up to a certain thickness when applied to ware in spite of definite forces (gravity, inertia, and centrifugal force) tending to make it flow. It is the property commonly spoken of as shortness. The mobility is the property which makes an enamel flow more or less readily under forces greater than the yield value. The desirable condition of an enamel is a yield value commensurate with the thickness of coating desired, and a high mobility. (*Chem. Abs.*, **18,** 3263 (1924); *Chem. and Ind.*, **44B,** 11 (1925).)

Cooke, R. D.

LITERATURE ON PLASTICITY AND SETTING-UP OF ENAMEL SLIPS. *Bull. Amer. Ceram. Soc.*, **5** [5], 232 (1926).

***Cooke, R. D.**

BRINGING RESEARCH UP-TO-DATE. *Bull. Amer. Ceram. Soc.*, **6,** 227 (1927).—A discussion of some new tools for the research worker which have come into use within the past 10 or 15 years, but which have not been accepted as fully as they should be in order to be strictly up to the minute in research methods. These include the microscope, hydrogen ion, colloid chemistry, and physics. (*Ceram. Abs.*, **6,** 453 (1927).)

Cooke, R. D.

ENAMEL SYMPOSIUM. See Jaeger, F. G. (this *Bibliography*, **p.** 161).

EFFECT OF MUFFLE ATMOSPHERE ON FIRING ENAMELS. See *Bull. Amer. Ceram. Soc.*, Discussion (this *Bibliography*, p. 43).

PLASTIC PROPERTIES OF ENAMEL SLIP. See this *Bibliography*, p. 44.

Cooper, H. S.

ENAMEL OPACIFIER FROM ZIRCONIUM SILICATE. U. S. Pat. 1,502,421, July 22, 1924.—Native zirconium silicate is subjected to wet-milling to reduce it to an extremely fine condition of subdivision and is then treated with acid, *e g.*, hydrochloric or sulphuric, washed, dried, and strongly ignited. U. S. Pat. 1,502,422 specified a similar wet milling followed by treatment with concentrated sulphuric acid and removal of acid and soluble substances formed. (*Ceram. Abs.*, **3,** 281 (1924); *Chem. Abs.*, **18,** 2951 (1924); *Chem. and Ind.*, **43B,** 830 (1924).)

Cooper, H. S.

WHITE ENAMEL FOR METALS. U. S. Pat. 1,510,829, Oct. 7, 1924.—A compound for producing a white opaque enamel coating on metals comprises, as opacifying ingredients, a cerium compound and another rare-earth compound occurring in monazite

sand, *e.g.*, residues left from thorium extraction. (*Ceram. Abs.*, **4**, 5 (1925); *Chem. Abs.*, **18**, 3693 (1924); *Chem. and Ind.*, **43B**, 1014 (1924).)

Cooper, H. S.

ENAMEL. U. S. Pat. 1,517,618, Dec. 2, 1924.—An enamel composition comprises ZrO_2 together with about two-thirds of its weight of an opacifying compound such as tin oxide or sodium metantimonate. (*Ceram. Abs.*, **4**, 34 (1925); *Chem. Abs.*, **19**, 386 (1925); *Chem. and Ind.*, **44B**, 100 (1925).)

Cope, Harold F.

BACK OF PORCELAIN ENAMELS—WHAT?[1] *Enamelist*, **4** [5], 9 (1927).—The advantages and use of pure iron as an enameling base are discussed.

Cox, I. F.

DISCUSSION ON "THE RELATIVE MERIT OF HEAT-RESISTING ALLOYS FOR ENAMEL FIRING RACK." *Bull. Amer. Ceram. Soc.*, **2**, 4 (1923).—The composition of the furnace atmosphere, the fuel used in firing, and other furnace conditions will have a considerable effect on the degree of oxidation of metal parts. This is a function also of temperature, and this temperature would have to be known accurately to obtain any strictly comparable results. For instance, calorized steel is recommended only for intermittent service above 1700°F and for continuous service, at or below that temperature. The tests should be subjected to actual commercial conditions wherever possible. Two alloys mentioned in Mr. Manson's discussion of Mr. Poste's paper occupy a different relative position at 2000°F than they do in Mr. Poste's experiments at 1700°F. Cost of replacing and lost production during the time required for replacement must often be taken into consideration in figuring costs. See E. P. Poste (this *Bibliography*, p. 245).

***Crane, A. T.**

PRODUCING ORNAMENTAL ENAMEL DESIGNS. See Nicholas, F. B. (this *Bibliography*, p. 223).

***Cribben and Sexton Mfg. Co.**

HIGH QUALITY ENAMEL PRODUCT PROVES THAT CLEANLINESS PAYS. See *Ceram. Ind.* (this *Bibliography*, p. 51).

GAS-FIRED ENAMELING FURNACES WITHOUT MUFFLES. See Clark, H. H. (this *Bibliography*, p. 68).

Cross, A. T.

ENAMELING OR JAPANNING HOLLOW ARTICLES. U. S. Pat. 303,817, Aug. 19, 1884.—Improved method for coating hollow articles having an open aperture so that the coating of enamel or japan may have a sharp terminal line at the boundary edge of the hollow aperture, thus adapting the same to form a clean-cut joint with other parts or materials adapted to enter the aperture. Method consists in applying a temporary removable plug to the aperture prior to the process of coating and baking, with the subsequent forcible removal of the plug.

Crossley, P. B.

VITREOUS COATINGS. British Pat. 217,319, Mar. 14, 1923.—Wire, plates, rails or other articles are coated with vitreous material in which mica, asbestos, or similar silicate of laminated structure is incorporated. A vitreous material is used which has a melting point below the temperature at which the silicate begins to effloresce, about 900°, so that the dielectric and other properties of the silicate are preserved. The coating com-

[1] From article in *Pure Iron Era*.

prises preferably borates low in SiO_2 and alkali and has a coefficient of expansion approximately the same as that of the metal article. It may contain SiO_2 under 5%, PbO 68 to 75%, and the remainder B_2O_3. A little clay, starch, or gum may be used to facilitate application of the coating to the metal article which is then fired *in situ;* or, the coating may be applied either by passing the article through a molten bath of the material or by subjecting it to a spray of the molten vitreous compound from an oxyacetylene spraying apparatus. (*Chem. Abs.*, **19,** 386 (1925); *Chem. and Ind.*, **43B,** 675 (1924).)

***Crown Stove Co.**

CABINET SANDBLAST PROVES POPULAR. See *Ceram. Ind.* (this *Bibliography*, p. 55).

Cunynghame, H. H.

ENAMELING UPON METALS. *Jour. Roy. Soc. Arts*, **48,** 137, 150, 162, and 173 (1900).—The different styles of enameling are cloisonné, champleve, bassetaille, Limoges painted, and miniatures. The enamels used consist of flint glass with various proportions of oxide of lead. That used for watches and jewelery contains 20 or 30%; the use of 45% produces a dense flint suitable for enamels in the Limoges style. Large additions of soda or potash increase the fusibility of enamels, but render them more easily affected by moisture. Borax glasses are also affected by moisture, besides being liable to crack. The coloring is imparted by the addition of certain metallic oxides. Gold gives a red; uranium and antimony, a yellow; cobalt, a blue; manganese, a violet; various mixtures of iron, chromium, copper, zinc, and cobalt give greens; a mixture of cobalt, manganese, and iron produces black; iron and manganese, and also nickel, give brown; oxide of tin, white arsenic, or phosphate of lime produces an opaque white, iridium, a black or gray; platinum, a gray; cobalt blue combined with uranium an indigo; yellowish green iron, mixed with oxide of iron, and manganese forms a red. The various shades of color are largely dependent upon the states of oxidation. About 2% of potassium nitrate may be added to prevent the lead from becoming reduced. The longer the heating, the better the result. It is desirable to try each enamel before it is used by running cold water over it while just so hot that it can be touched. If this does not crack it it may be considered sound. (*Chem. and Ind.*, **19,** 246 (1900).)

***Cunynghame, Henry H.**

REFERENCE BOOKS ON ENAMELS. See *Jour. Amer. Ceram. Soc.* (this *Bibliography*, p. 166).

Curren, J. F.

SPRAYING CABINET. U. S. Pat. 1,608,082, Nov. 23, 1926.—In combination, a cabinet having an open front side, an enclosed reclaiming chamber located back of the cabinet, a vertical stack extending upwardly from the upper side of the chamber and communicating therewith, two pipes connected with the upper side of the chamber, one at each side of the stack, and extending forward through the back of the cabinet, a nozzle connected to the front of each pipe having an open front end, the ends of the nozzles being turned toward each other, means within the pipes for causing air to be drawn rearwardly therethrough, and a liquid container in the lower portion of the cabinet having an area substantially equal to the area of the bottom of the cabinet. (*Ceram. Abs.*, **6,** 10 (1927).)

Cushman, A. S.

CAUSE OF THE CEMENTING VALUE OF ROCK POWDERS AND THE PLASTICITY OF CLAYS. *Jour. Amer. Chem. Soc.*, **25,** 451 (1903).—In summarizing, the following results are presented: (1) The cementing power of rock powders is a property similar to the

plasticity of clays. (2) All rock powders that have cementing power show the same peculiar relation to water that is shown by substances that possess an amorphous colloid structure, *i.e.*, that can be dehydrated and rehydrated, until, by prolonged high heating, the structure is destroyed.

Cushman, A. S.

COLLOIDAL THEORY OF PLASTICITY. *Trans. Amer. Ceram. Soc.*, **6**, 65 (1904).—The following points were presented: (1) Both plasticity and binding power are merely manifestations of a colloid modification of matter which exists in rocks and clays. (2) The activity of these useful qualities depends upon the characteristics of the special colloids that may be present as well as upon their past history, and the modifying effect upon them of saline and organic solutions. (3) Absorptive qualities of clays, such as their ability to stick when touched with the tongue, and as exhibited by their occasional use as "lakes," clarifying agents, etc., is to be ascribed to the same cause.

D'Adrian, Alexander L. Duval

ENAMEL AND METHOD OF MAKING THE SAME. U. S. Pat. 1,443,813, Jan. 30, 1923.—The method of making an enamel batch, which consists in adding lepidolite to an enamel frit and fusing the lepidolite therewith to produce an enamel. (*Chem. and Ind.*, **42A**, 270 (1923).)

Daeves, K.

TYPES OF IRON AND STEEL WHICH DO NOT RUST OR IGNITE. *Prazison*, **1**, 270; *Physik Ber.*, **3**, 667 (1922).—The difficulties encountered in working noncorrodible, high-Cr steels are lessened by reducing the carbon content and by corresponding heat treatment. Ordinary rust-proof steel consists of about 13% Cr, 0.5% Ni, and 0.7–1.0% carbon. After hardening, it has a rigidity of 110–170 kg. mm.^{2}, which is not affected by heating to 500°. The coefficient of expansion is 11×10^{-6}. Both heat and electric conductivity are less than for carbon steel. Cold work decreases resistance to rusting. Resistance to hydrochloric and sulphuric acid is not perfect but atmospheric oxidation does not take place even at 900°. Where special hardness is not required a steel of 13% chromium and 0.1% carbon is recommended. These steels may be cast, forged, stamped, machined, etc. For surgical or dental instruments a higher Ni content is recommended. All these steels are useful for physical and chemical apparatus used at high temperatures. Their cost is about 10 to 12 times that of ordinary steel. (*Ceram. Abs.*, **3** [1], 5 (1924).)

Daniels, S., Zimmerman, A. C., and Watson, J. A.

COATING ALUMINUM OR MAGNESIUM OR THEIR ALLOYS WITH SILICATES. British Pat. 252,070, Feb. 16, 1925.—Heat treatments before and after coating with silicate solutions are described for providing a permanent coating which renders the metal impervious and protects it from corrosion. (*Ceram. Abs.*, **6** [7], 266 (1927).)

Danielson, R. R.

CLEANING SHEET METAL AND IRON FOR ENAMELING PURPOSES. *Jour. Amer. Ceram. Soc.*, **2**, 883 (1919).—Cleaning may be divided into the following processes: (1) removal of grease and dirt, (*a*) scaling, and (*b*) cleaning compounds; (2) removal of iron oxide, (*a*) sandblasting, (*b*) pickling with acids, and (*c*) electrolytic pickling; (3) neutralizing baths; (4) drying of the ware. (1*a*) *Scaling:* Ware is heated in muffle furnace to 1400°F for 5 to 10 minutes. Dilute acid, usually discarded acid from pickling tanks, is sometimes sprinkled on the ware just before it is placed in the furnace to assist in the formation of a light scale that will separate easily from the metal. Objections

to scaling are: (1) metal may warp and (2) may form heavy coat of iron oxide that may lengthen time of pickling. (1*b*) *Cleaning compounds:* These are usually composed of one or more of the following: sodium hydroxide, sodium carbonate, ammonium carbonate, borax, trisodium phosphate, sodium silicate, resin in the presence of caustic forming soaps, and soap. These cleaners lessen the surface tension of the grease and oil and thus remove them from the metal. The action is principally a mechanical one. Bath should be kept near the boiling point and should be agitated. Electric current accelerates the work. Some cleaners may be used in removing enamel from spoiled pieces. Data regarding this usage are given. (1) Two pounds of cleaner per gallon of water removed a vitreous enamel from kitchenware in 36 hours without current. (2) Two pounds of cleaner per gallon of water, bath kept at boiling point for 24 hours, removed a vitreous enamel in splendid shape. (3) One-half pound of cleaner per gallon of water, with temperature of bath 180°F and reverse current at 6 amperes, removed a white enamel in 6 hours. (2*a*) *Sandblasting:* Steel shot is taking the place of sand, thus eliminating dust. Sandblast has the following advantages over pickling: (1) presence of acid is harmful and (2) eliminates scaling or cleaning as it removes slight film of oil and dirt as well as iron oxide. Probably would not be successful on light gage metals or irregular shapes. (2*b*) *Pickling:* 2 to 15% by weight of H_2SO_4 or HCl at a temperature from 25 to 80°C is used. Bubbles of hydrogen aid in forcing iron oxide layer off. Pickling is more efficient with the lower per cent acid content. Niter cake has been used successfully. In this case best results are obtained with the bath close to the boiling point. Life of bath is short as compared with that of acid bath. Typical bath for niter cake and sulphuric acid includes 700 gallons water, 275 pounds 66°Bé sulphuric acid, and 100 pounds niter cake; 30 pounds of each acid and niter cake were added daily. Bath used for week, cleaning 3500 sq. ft. It cleaned ware in 2 to 4 minutes that required 10 to 30 minutes in 6% hydrochloric acid. Advantages of niter cake solutions are: (1) saving in cost of pickling, (2) absence of acid burning and etching, and (3) ease in handling. Conditions for efficient pickling are: (1) agitation and (2) heating bath; (*a*) 160–180°F for acids, (*b*) boiling point for niter cake. (2*c*) *Electrolytic pickling:* If ware is the anode, the oxygen liberated mechanically detaches the oxide which later might dissolve in the electrolyte. If ware is the cathode, the hydrogen liberated reduces some of the oxide and also aids mechanically in flaking it off. Work which required 43 minutes for pickling in a 4% H_2SO_4 bath at boiling temperature was pickled in an electrolytic bath in 5 minutes with a current of 9.5 amperes and 2.7 volts. Advantages of electrolytic pickling are: (1) speed of pickling, (2) saving in cost ($^1/_4$ that for acid), (3) evenness of pickling. (3) *Neutralizing bath:* In mottled ware, the ware is simply passed through rinse water and dried or left under water until ready for dipping. With other ware, the acid must be neutralized by immersing the ware in a weak alkaline bath (sometimes 1 pound soda ash to 25 gallons of water). The better neutralizing agents are made of 2 parts NaOH and 1 part Na_2CO_3 (12 pounds NaOH and 6 pounds Na_2CO_3 in 400 gallons of water). Solutions of this kind are effective over a period of several days whereas a soda bath, becomes ineffective after $^1/_2$ to 1 day of use. (4) *Drying:* Ware is passed into driers heated from 150–230°F. These are heated by waste heat from the enameling furnaces, gas burners, or steam coils. In case of waste heat, soot or dirt must be kept from the ware. With gas driers, combustion must be complete and dirt kept from the ware. (*Chem. and Ind.*, **39A**, 111 (1920); *Chem. Abs.*, **12**, 1201 (1918).)

Danielson, R. R.

CLASSIFICATION OF ENAMELS FOR SHEET STEEL. *Jour. Amer. Ceram. Soc.*, **3**, 961 (1920).—In this paper the compositions have been given of typical enamels applied to sheet steel with reasons for their use. The field of possible composition is not covered entirely but the purpose is to present proven compositions which yield the several kinds

of commercial enamels and enable the makers of enamels to compare them with their own. *Sheet steel enamels:* (*a*) single coat of enamel applied to metal, and mottled by formation of rust spots, and given a single firing. Examples in Table I. (*b*) Three-coat enamels (ground-coat and two cover enamels). Examples in Tables III and V.

TABLE I. GRAYWARE ENAMELS

	Raw Batch Composition of Frits		
	A	*B*	*C*
Feldspar	30.0	40.0	48.0
Borax	28.5	30.5	40.0
Quartz	19.0	10.0	
Soda ash	8.0	6.5	3.0
Sodium nitrate	4.0	5.5	4.0
Fluorspar	3.0	1.5	
Bone ash	5.0	4.5	3.5
Antimony oxide	2.5	1.5	1.5
Total	100.0	100.0	100.0

Mill batch: frit 100, clay 6.0, magnesium carbonate 0.25, water 50.0. Enamel A is typical of some of the earlier types of grayware enamel containing a comparatively high content of quartz in addition to feldspar as a refractory. It contains considerable opacifying agents in the form of fluorspar, bone ash, and antimony oxide. Enamel B is a type showing the tendency to reduce the amount of quartz and replace it with feldspar. Enamel C is a type much in use at the present time. Quartz has been eliminated entirely and has been replaced by feldspar which remains as the sole refractory. Fluorspar has been eliminated and the boric acid increased to care for the decrease of other fluxes. It is to be noted in the three types that the content of sodium oxide remains fairly constant, and this is undoubtedly due to the fact that higher amounts of sodium oxide give difficulties from blistering and boiling. The next change in this class of enamels will probably be in the elimination of antimony oxide and its replacement by some opacifying agent to which there is not attached the prejudice now associated with antimony.

	Percentage Composition of Melted Frits		
	A	*B*	*C*
Feldspar	37.2	50.3	62.05
Quartz	23.5	12.6	
B_2O_3	12.8	14.1	18.9
Na_2O	13.4	13.5	12.6
Fluorspar	3.7	1.9	
Bone ash	6.3	5.7	4.5
Antimony oxide	3.1	1.9	1.95
Total	100.0	100.0	100.0

TABLE II. GRAYWARE ENAMELS

Empirical Formulas

(*A*) $\left.\begin{matrix}0.05\ K_2O \\ 0.77\ Na_2O \\ 0.18\ CaO\end{matrix}\right\}$ $\left.\begin{matrix}0.103\ Al_2O_3 \\ 0.312\ B_2O_3 \\ 0.019\ Sb_2O_3\end{matrix}\right\}$ $\left\{\begin{matrix}1.39\ SiO_2 \\ 0.079\ F_2 \\ 0.033\ P_2O_5\end{matrix}\right.$

$SiO_2/B_2O_3 = 4.46$, $SiO_2/Al_2O_3 = 13.5$

(*B*) $\left.\begin{matrix}0.116\ K_2O \\ 0.676\ Na_2O \\ 0.208\ CaO\end{matrix}\right\}$ $\left.\begin{matrix}0.228\ Al_2O_3 \\ 0.545\ B_2O_3 \\ 0.017\ Sb_2O_3\end{matrix}\right\}$ $\left\{\begin{matrix}2.18\ SiO_2 \\ 0.065\ F_2 \\ 0.048\ P_2O_5\end{matrix}\right.$

$SiO_2/B_2O_3 = 4.0$, $SiO_2/Al_2O_3 = 9.56$

(*C*) $\left.\begin{matrix}0.153\ K_2O \\ 0.721\ Na_2O \\ 0.126\ CaO\end{matrix}\right\}$ $\left.\begin{matrix}0.310\ Al_2O_3 \\ 0.805\ B_2O_3 \\ 0.019\ Sb_2O_3\end{matrix}\right\}$ $\left\{\begin{matrix}2.18\ SiO_2 \\ 0.042\ P_2O_5\end{matrix}\right.$

$SiO_2/B_2O_3 = 2.7$, $SiO_2/Al_2O_3 = 7.03$

In these calculations feldspar has been assumed to be 71% SiO_2, 17% Al_2O_3, 8% K_2O, and 4% Na_2O.

TABLE III. GROUND COATS

	Raw Batch Composition of Frits		
	A	*B*	*C*
Borax	30.0	30.0	39.5
Feldspar	22.0	27.0	20.5
Quartz	29.0	20.5	22.5
Soda ash	5.0	9.8	5.0
Soda niter	4.6	5.0	4.7
Fluorspar	6.0	6.0	6.0
Cobalt oxide	0.4	0.5	0.4
Manganese oxide	2.0	1.2	1.0
Nickel oxide	1.0		0.4
Total	100.0	100.0	100.0

Mill batch: frit 100.0, clay 7.0, borax 1.5, water 50.0.

	Percentage Composition of Melted Frits		
	A	*B*	*C*
Feldspar	27.2	34.3	26.9
Quartz	36.0	26.2	29.6
B_2O_3	13.6	14.0	18.9
Na_2O	11.6	15.8	14.4
CaF_2	7.4	7.6	7.9
CoO	0.5	0.63	0.5
MnO	2.47	1.5	1.3
NiO	1.23		0.5
Total	100.0	100.0	100.0

TABLE IV. GROUND COATS

Empirical Formulas

(*A*) $\left.\begin{matrix}0.5490\ Na_2O\\0.0615\ K_2O\\0.2530\ CaO\\0.0164\ CoO\\0.0757\ MnO\\0.0444\ NiO\end{matrix}\right\}$ $\begin{matrix}0.1203\ Al_2O_3\\0.5175\ B_2O_3\end{matrix}$ $\left\{\begin{matrix}2.445\ SiO_2\\0.253\ F_2\end{matrix}\right.$

$SiO_2/B_2O_3 = 4.73$, $SiO_2/Al_2O_3 = 20.3$

(*B*) $\left.\begin{matrix}0.6399\ Na_2O\\0.0673\ K_2O\\0.2260\ CaO\\0.0182\ CoO\\0.0486\ MnO\end{matrix}\right\}$ $\begin{matrix}0.1322\ Al_2O_3\\0.4620\ B_2O_3\end{matrix}$ $\left\{\begin{matrix}1.9200\ SiO_2\\0.2260\ F_2\end{matrix}\right.$

$SiO_2/B_2O_3 = 4.16$, $SiO_2/Al_2O_3 = 14.5$

(*C*) $\left.\begin{matrix}0.6222\ Na_2O\\0.0558\ K_2O\\0.2502\ CaO\\0.0162\ CoO\\0.0374\ MnO\\0.0182\ NiO\end{matrix}\right\}$ $\begin{matrix}0.1120\ Al_2O_3\\0.6710\ B_2O_3\end{matrix}$ $\left\{\begin{matrix}2.008\ SiO_2\\0.2502\ F_2\end{matrix}\right.$

$SiO_2/B_2O_3 = 3.0$, $SiO_2/Al_2O_3 = 17.9$

Ground *A* is a refractory enamel because of its high content of quartz and low amount of fluxes and for that reason is not adapted to lighter gage shaped ware or to flat ware, such as signs and stove work, which would tend to buckle in the comparatively high temperature required for its fusion. It is used with success on heavy gages of shaped ware such as enameled pipe, pails, and containers. Because of its high content of metallic oxides, it is a tough, durable enamel giving excellent service on ware subjected

to hard service. Ground *B* is one in use for flatware such as stovework, table tops, and two- or three-color signs and for medium gage shaped ware. It is a high sodium oxide enamel with a medium content of refractories and is fired at a medium temperature. Ground *C* is a type which has been used on light gage drawn and spun ware. Because of its high boric oxide content it is not desirable for the manufacture of flat ware where there is an opportunity for free expansion and contraction of the metal. It has a low fusion temperature, because of its low content of refractories and increased content of fluxes. Cover enamels for ordinary three-coat ware may be classified as: (*a*) white enamels, Table V; (*b*) colored enamels, Table VII.

TABLE V. WHITE-COVER ENAMELS

	Raw Batch Composition of Frits		
	A	*B*	*C*
Borax	28.0	27.0	21.0
Feldspar	25.0	31.0	31.0
Quartz	19.0	17.0	22.0
Soda ash	3.5	3.5	3.5
Sodium nitrate	3.5	3.5	3.5
Fluorspar	5.0	5.0	
Cryolite	12.0	12.0	17.0
Antimony oxide	4.0	1.0	2.0

Mill batch: frit 100.0, clay 6.0, tin oxide 7.0, magnesium carbonate 0.5, water 60.0.

	Percentage Composition of Melted Frits		
	A	*B*	*C*
Feldspar	30.1	37.0	35.8
Quartz	23.0	20.5	25.5
B_2O_3	12.3	11.8	8.9
Na_2O	9.4	9.2	7.8
CaF_2	6.0	6.0	
Cryolite	14.4	14.3	19.7
Antimony oxide	4.8	1.2	2.3
Total	100.0	100.0	100.0

TABLE VI. WHITE-COVER ENAMELS

Empirical Formulas

(*A*) $\left.\begin{matrix}0.067\ K_2O \\ 0.730\ Na_2O \\ 0.203\ CaO\end{matrix}\right\}$ $\left.\begin{matrix}0.226\ Al_2O_3 \\ 0.458\ B_2O_3 \\ 0.044\ Sb_2O_3\end{matrix}\right\}$ $\left\{\begin{matrix}1.95\ SiO_2 \\ 0.741\ F_2\end{matrix}\right.$

$SiO_2/B_2O_3 = 4.27$, $SiO_2/Al_2O_3 = 8.64$

(*B*) $\left.\begin{matrix}0.084\ K_2O \\ 0.716\ Na_2O \\ 0.200\ CaO\end{matrix}\right\}$ $\left.\begin{matrix}0.252\ Al_2O_3 \\ 0.448\ B_2O_3 \\ 0.011\ Sb_2O_3\end{matrix}\right\}$ $\left\{\begin{matrix}2.03\ SiO_2 \\ 0.735\ F_2\end{matrix}\right.$

$SiO_2/B_2O_3 = 4.53$, $SiO_2/Al_2O_3 = 8.06$

(*C*) $\left.\begin{matrix}0.098\ K_2O \\ 0.902\ Na_2O\end{matrix}\right\}$ $\left.\begin{matrix}0.337\ Al_2O_3 \\ 0.398\ B_2O_3 \\ 0.025\ Sb_2O_3\end{matrix}\right\}$ $\left\{\begin{matrix}2.66\ SiO_2 \\ 0.880\ F_2\end{matrix}\right.$

$SiO_2/B_2O_3 = 6.68$, $SiO_2/Al_2O_3 = 7.90$

White enamel *A* is similar to German enamels in which the feldspar is low and the antimony oxide high. Very often this type is made up with small additions of clay in the raw batch, which would tend to overcome the effect of small amounts of feldspar. White enamel *B* shows an increase in the feldspar content and a decrease in the antimony oxide with the same content of fluorspar and cryolite. The increase in feldspar is compensated for by a decrease in quartz content. White enamel *C* is a type which is used considerably where a very opaque enamel is demanded. It is the most refractory

enamel of the three, carrying increased refractories and a smaller content of borax. This decrease in borax is taken care of by the replacement of fluorspar by cryolite, which exerts a greater fluxing action.

TABLE VII. GLASS FRITS FOR COLORED ENAMELS

	Raw Batch Composition of Frits A	B
Borax	29.0	29.0
Feldspar	24.0	14.0
Quartz	30.0	28.0
Soda ash	10.0	10.0
Sodium nitrate	3.0	5.0
Fluorspar		7.0
Cryolite	4.0	7.0
Total	100.0	100.0

Mill batch: frit 100.0, clay 6.0, magnesium carbonate 0.5, water 50.0, necessary additions of oxides or stains.

	Percentage Composition of Melted Frits A	B
Feldspar	30.0	17.75
Quartz	37.4	35.25
B_2O_3	13.15	13.7
Na_2O	14.45	15.7
Fluorspar		8.8
Cryolite	5.0	8.8
Total	100.0	100.0

TABLE VIII. GLASS FRITS FOR COLORS

Empirical Formulas

(*A*) $\left.\begin{matrix}0.917\ Na_2O \\ 0.083\ K_2O\end{matrix}\right\}$ $0.202\ Al_2O_3$, $0.615\ B_2O_3$ $\left\{\begin{matrix}3.17\ SiO_2 \\ 0.23\ F_2\end{matrix}\right.$

$SiO_2/B_2O_3 = 5.15$, $SiO_2/Al_2O_3 = 15.7$

(*B*) $\left.\begin{matrix}0.717\ Na_2O \\ 0.033\ K_2O \\ 0.250\ CaO\end{matrix}\right\}$ $0.111\ Al_2O_3$, $0.421\ B_2O_3$ $\left\{\begin{matrix}1.75\ SiO_2 \\ 0.532\ F_2\end{matrix}\right.$

$SiO_2/B_2O_3 = 4.17$, $SiO_2/Al_2O_3 = 15.8$

Glass *A* is one which works well for dark colors because of its small content of opacifying agents. Glass *B* with its high content of opacifiers serves well for light-colored enamels as it tends to mask the dark underlying ground coat.

Black: Glass *A* plus 4% black cobalt oxide and 2% manganese dioxide in raw batch.

Black: Glass *A* plus 1.5% cobalt oxide, 3.0% manganese oxide, 1% chromium oxide, 0.5% copper oxide, and 1.5% iron oxide in raw batch.

The following colors may be produced by additions below to either Glass *A* or Glass *B* in the mill: (*a*) yellow: 3 to 5% cadmium sulphide; (*b*) green: 3 to 5% chromium oxide. (*Chem. Abs.*, **16**, 1304 (1922); *Chem. and Ind.*, **40A**, 117 (1921).)

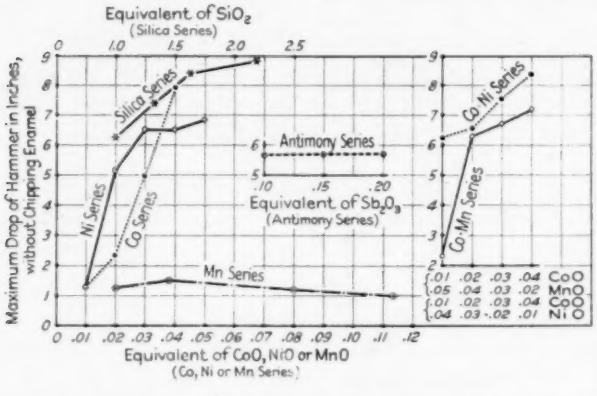
Danielson, R. R.

EFFECT OF VARIATION IN THE COMPOSITION OF GROUND COATS FOR SHEET-IRON ENAMELS. *Trans. Amer. Ceram. Soc.*, **18**, 343 (1916).—Results for various series of batches are given. The following conclusions are drawn: (1) Best results were obtained by the use of cobalt and nickel or by a combination of the two. (2) Fair results were obtained from cobalt and manganese, but when together, cobalt is probably the active agent. (3) Best combination, 0.4% CoO and 0.75% NiO. (4) Best with MnO_2,

0.5% CoO, and 1.5% MnO_2. The starting formula used, disregarding the cobalt, nickel, and manganese oxides, is as follows:

0.25 K_2O 0.50 Na_2O 0.25 CaO	0.15 Al_2O_3 0.50 B_2O_3	2.0 SiO_2 0.25 F_2

Cobalt and nickel oxides have about the same effect in regard to toughness, while manganese oxide decreases the toughness very markedly. Additions of cobalt oxide to either manganese or nickel seem to increase the toughness. These results tend to show that cobalt oxide is an important constituent for developing toughness of ground coats.



Furthermore, toughness is absolutely essential in any enamel which serves as a good ground. The introduction of part of the flint into the enamel batch instead of into the frit itself seems to increase the toughness, but at the same time, makes the enamel more refractory. The enamels of this series have less the appearance of a glass which probably accounts for their greater toughness. Low borax or high lime enamels will not make good ground as they are very porous and show very low toughness. Variations in the antimony oxide do not affect the toughness either way, but do add to the whiteness of the enamel. It might be possible that, by working in this direction, a white ground could be obtained. *White cover coats:* The results with the finish white show that best enamels were obtained on those first coats in which cobalt was present. For every series, the quality of the enamel was improved with the increase of cobalt. In no case were good results obtained with the plates coated with a white first coat, such defects as pinholing, blistering, and bubbling being more or less present. Batch composition of this coat was:

Borax	20.0	Saltpeter	2.25
Feldspar	32.0	Cryolite	16.0
Flint	21.5	Antimony	2.5
Soda	10.0	Whiting	5.0

Additions in mill, 7% tin oxide, $^1/_2$% magnesia, and 6% clay. Discussion of this article, *Trans. Amer. Ceram. Soc.*, **18,** 896 (1916). Explanation of how comparative results of adhesive power was obtained, by Danielson. Discussion by E. P. Poste, R. D. Landrum, W. A. Denmead, and H. F. Staley. (*Chem. Abs.*, **11,** 283 (1917); *Chem. and Ind.*, **36,** 717 (1917).)

Danielson, R. R.

COMPOSITION FOR COATING METAL SURFACES. U. S. Pat. 1,629,072, May 17, 1927. (Free of use in U. S. A.) A mixture of silica (64.9 parts), borax (36.96 parts), sodium nitrate (6.95 parts), and triplumbic tetroxide (8.17 parts) is sintered at 800 to 900°, the product being ground and mixed with enamel clay (93 parts) and water to form a paste which is employed to protect metallic surfaces in selective carburization.

The surfaces are pickled in acid before application of the paste. (*Ceram. Abs.*, **6** [12], 569 (1927); *Chem. and Ind.*, **46B**, 630 (1927).)

***Danielson, R. R.**

MICROSCOPIC STUDY OF GROUND-COAT AND COVER-COAT ENAMEL REACTIONS. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 37).

MODIFICATION OF THE MOLECULAR FORMULA FOR GLAZE AND ENAMEL CALCULATIONS. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 38).

WET-PROCESS ENAMELS FOR CAST IRON. (Discussion.) *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 38).

ZIRCONIA IN ENAMELS. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 41).

PLASTIC PROPERTIES OF ENAMEL SLIP. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 44).

QUESTION OF ANNEALING PORCELAIN PARTS PROVED TO BE VERY INTERESTING. See *Enamelist* (this *Bibliography*, p. 106).

TRANSPARENT ENAMELS. See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 41).

Danielson, R. R., and Frehafer, M. K.

EFFECT OF SOME SUBSTITUTES FOR TIN OXIDE ON THE OPACITY OF WHITE ENAMELS FOR SHEET STEEL. *Jour. Amer. Ceram. Soc.*, **6** [5], 634 (1923).—

Batch Weight of Frit Used

Borax	25	Sodium nitrate	3
Feldspar	32	Cryolite	12
Quartz	18	Antimony oxide	2
Soda ash	4	Fluorspar	4

TYPE AND PERCENTAGE OF OPACIFIER USED

No.	Opacifier	(%)	Source	Remarks
1	Tin oxide	7	Trade	
5	Sodium antimonate	7	Trade	
6	Sodium antimonate	9	Trade	
7	Sodium antimonate	11	Trade	
11	Titanium oxide	7	Trade	Impure material
9	Magnesium aluminate	7	Bureau	Calcined at approx. 1200°C
2	Zinc oxide	7	Trade	
3	Zinc oxide	11	Trade	
8	Zinc aluminate	7	Bureau	$ZnO\ Al_2O_3$ calcined at approx. 1200°C
16A	Zinc aluminate	9	Bureau	$ZnO\ Al_2O_3$ calcined at approx. 1000°C (2 hrs.)
16B	Zinc aluminate	9	Bureau	$ZnO\ Al_2O_3$ not calcined
16D	Zinc aluminate	9	Bureau	$2ZnO{\cdot}3Al_2O_3$ not calcined
13	Commercial substance	7	Trade	
*15A	Feldspar opacifier	9	Bureau	Calcined at 1000°C
4	Zirconium oxide	7	Trade	
14	Zirconium oxide	9	Trade	
10	Zirconium product	7	Trade	Claimed to be zirconium oxide
17	Zirconium product	9	Trade	Claimed to be zirconium oxide
18	Zirconium product	11	Trade	Claimed to be zirconium oxide
12	Zirconium silicate A	7	Trade	From dealer A
19	Zirconium silicate A	9	Trade	
20	Zirconium silicate A	11	Trade	
25	Zirconium silicate B	7	Trade	From dealer B calcined 1000°C
25A	Zirconium silicate B	7	Trade	
26	Zirconium silicate B	9	Trade	
27	Zirconium silicate B	11	Trade	

* Feldspar 51.0, soda ash 12.0, whiting 13.0, fluorspar 7.0, cryolite 9.0, sodium antimonate 8.0; ground in ball mill.

Ground Coat Used

Frit		Mill	
Borax	28.5	Frit	100
Feldspar	31.2	Clay	6
Flint	20.0	Borax	2
Soda ash	9.0	Water	50
Sodium nitrate	4.0		
Fluorspar	6.0		
Cobalt oxide	.35		
Manganese oxide	.95		

(1) Zirconium oxide and sodium antimonate are apparently the best substitutes investigated and are nearly as good as tin oxide itself. Next in order of excellence is the sample of zirconium silicate from dealer B. If either of the first two is used in quantities of about 11% the opacity is strictly comparable with that of 7% of tin oxide. Feldspar opacifier, zinc aluminate, and "commercial substitute" in such quantities as used here (7 and 9%) fail to satisfy the requirements for a good opacifier, but may be classed as fair. (2) The opacity does not always increase as the amount of opacifier increases. Apparently an "overloading" is possible which may be deleterious to the opacifier itself. (3) Within certain limits, it is impossible to classify enamels for opacity, with accuracy, by merely looking at them. Even the consensus of opinion of several observers does not obviate the possibility of mistakes. If the samples were equally shiny and of the same color (all blue, all white, or all yellow) such classification would have more value. (4) By determining the spectral reflection curve of an enamel, and from this computing its total reflection for sunlight, an accurate means is provided for determining its relative opacity. This method is free from all errors of personal judgment. It is to be noted in this connection that primarily the diffuse reflection is involved in these measurements. (5) This investigation is preliminary to further work and it is not to be assumed that the opacifier included would not give distinctly different results if used in enamels of other compositions. Method for determining reflection values and a description of apparatus is included as Part II of article. (*Chem. Abs.*, **17,** 3589 (1923); *Chem. and Ind.*, **42A,** 605 (1923).)

Danielson, R. R., Hartshorn, T. D., and Harrison, W. N.

FACTORS AFFECTING WARPAGE OF SHEET IRON AND STEEL IN ENAMELING. *Jour. Amer. Ceram. Soc.*, **7** [5], 326 (1924).—The effects upon warpage of different methods of cleaning the metal, durations of firing periods, scaling practices, gages of metal, types of enamel, etc., are studied. Test pieces 16 x 16 inches are employed, several commercial enameling irons and steels being used and compared. Warpage is determined by obtaining the areas on five evenly spaced, vertical planes, parallel to one edge of the test piece, included between a flat, horizontal base plane and the contour of the test piece resting thereon. The average of the five areas in square centimeters is used to express numerically the degree of warpage. The conclusions are: (*a*) A wide divergence between the expansivities of the enamel and the metal base induces warpage. (*b*) There seems to be less tendency for the scaled metal to warp than for that cleaned chemically. (*c*) Thin metal is more sensitive to the factors affecting warpage than thicker metal. (*d*) Sudden, irregular cooling induces warpage. (*e*) Tendency to warpage is reduced by properly supporting the ware during firing and cooling. (*Chem. Abs.*, **18,** 3263 (1924).)

Danielson, R. R., and Lindemann, W. C.

METHOD FOR TESTING CROSS-BENDING STRENGTH OF ENAMELS. *Jour. Amer. Ceram. Soc.*, **8** [12], 795 (1925).—Methods which have been proposed for measuring the strength of enamels, by means of impact tests, are not entirely applicable to enameled flat ware, where the ordinary strains are due to bending of the sheets. An ap-

paratus has been devised by means of which bending stresses can be applied in gradual increasing increments so that the normal behavior of enamels under such stresses can be observed and measured. (*Enamelist*, **3** [10], 11 (1926); *Chem. Abs.*, **20,** 808 (1926); *Chem. and Ind.*, **45B,** 158 (1926).)

Danielson, R. R., and Reinecker, H. P.

PRODUCTION OF SOME WHITE ENAMELS FOR COPPER. *Jour. Amer. Ceram. Soc.*, **4,** 827 (1921).—The investigation deals with the development of some white enamels for copper watch dials, thermometer scale plates, and signs. The effect of varying Na_2O, PbO, cryolite, SiO_2, and B_2O_3 on the properties of the enamels was studied in twenty enamel compositions. The following conclusions were reached: (1) Correct melting is extremely important in the preparation of copper enamels: (*a*) slow air cooling of the frit is preferable to quenching in water; (*b*) repeated melting tends to promote opacity and to eliminate dissolved gases. (2) A somewhat reducing atmosphere during firing avoids oxidation of the copper. (3) Slight changes in enamel composition have a decided effect on the resultant properties. (4) Sodium oxide promotes gloss but reduces opacity very decidedly. (5) Lead oxide promotes fusibility without materially reducing opacity, except by dilution. (6) Cryolite is not a desirable flux or opacifier as it tends to develop a mat finish. (7) It is desirable to keep the boric oxide content low and good enamels may be produced without it. (8) By using "white arsenic" as an opacifier tin oxide is unnecessary. (9) The following were the best enamels obtained and these appear to be equal to a number of watch dial enamels examined: C-19 and C-20. (10) A second group of compositions which appear to promote results equal to those in use for thermometer scales, advertising letters, etc., are C-10, C-21, C-22, and C-24. In selecting these compositions, all factors such as opacity, gloss, texture, fit, and resistance to attack of copper have been considered.

BATCH COMPOSITIONS OF BEST ENAMELS (TO GIVE 100 PARTS MELTED)

	C-19	C-20	C-10	C-21	C-22	C-24
Quartz	34.8	32.8	30.0	30.8	31.0	31.0
Feldspar	1.3	1.3		1.3		
White lead	62.0	64.2	58.0	66.5		
Red lead					48.3	49.8
Potassium nitrate	3.2	3.2	2.4	3.2	3.2	3.2
Soda ash	1.9	1.9	4.3	1.9	2.3	3.4
Oxide arsenic	5.2	5.2	5.5	5.2	5.5	5.5
Potassium carbonate	2.3	2.3	5.0	2.3		
Cryolite			7.5			
Sodium nitrate	2.7	2.7		2.7	4.1	4.1
Tin oxide					10.0	10.0
Borax					4.1	

(*Chem. Abs.*, **16,** 808 (1922); *Chem. and Ind.*, **41A,** 102(1922).)

Danielson, R. R., and Reinecker, H. P.

WET-PROCESS ENAMELS FOR CAST IRON. *Jour. Amer. Ceram. Soc.*, **5,** 647 (1922); Bur. Stand., *Tech. Paper*, No. 246.—Wet-process enameling of cast iron is important because of its application to the enameling of stove parts, sanitary fittings, and hardware. This paper is a report of an extended investigation of wet-process enamels for cast iron, in connection with the use of a ground coat. Compositions used in dry-process enameling have served as a basis for the work, which includes a study of ground coats and white cover enamels. The effect of varying methods of preparing the frits, mill additions, and the relation of composition of the enamels to such properties as adherence, texture, and opacity have been carefully studied. *Ground coats:* Sintering of most ground coat frits has been found desirable in order to develop best adherence on the castings. Clay

gave best results as a mill addition for the ground coats, and flint and feldspar were found to be less satisfactory. Excessive additions of clay or flint produced flaking of the ground coat while feldspar tended to develop blistering. About 15% clay or 10% each of clay and flint are recommended as mill additions for the ground coats. Excessive additions of any one flux were not desirable, and best results were obtained when sodium, lead, and boric oxides were combined in more or less definite proportions. Sodium oxide in excess of about 10% gave rise to blistering. Boric oxide increased the firing range of the ground coats and was preferable to lead oxide on this account, although it tended to promote crawling of ground coats high in boric oxide if they were applied somewhat heavily. The best ground coats developed are Rg 26, 17, 1, 25, and 18 in order named. *Cover enamels:* Cover enamels were smelted in the usual manner. The mill additions consisted of 5% of clay, 8% tin oxide, and 45% of water, all based on the weight of the dry frit. For best results the cover enamel must be adapted to the ground coat in refractoriness. Boric acid increased the firing range of the enamels but tended to promote crawling, although this was less pronounced in the case of the more fusible compositions. Boric oxide improved the opacity when substituted for such fluxes as sodium and lead oxides. Cryolite increased opacity but additions above 10% based on the melted weight, tended to promote crawling. Considering all factors, cover enamels R 14, 11, 28, 1, and 18 gave best results.

BATCH COMPOSITIONS OF GROUND COATS

	Rg 1	Rg 17	Rg 18	Rg 25	Rg 26
Flint	69.90	69.90	69.90	69.90	66.30
Borax	36.96	36.96	26.07	26.07	36.96
Sodium nitrate	6.95	6.95	6.95	6.95	6.95
Red lead	8.17	4.08	12.24	8.17	8.17
Boric acid		7.08			6.37
Soda ash			3.04	9.88	

BATCH COMPOSITION OF WHITE COVER ENAMELS

	R 1	R 11	R 14	R 18	R 28
Feldspar	38.0	33.0	38.0	33.0	50.0
Flint	12.0	12.0	12.0	12.0	
Borax	24.52	24.52	10.9	38.14	54.5
Sodium nitrate	6.20	6.20	6.20	6.20	5.95
Soda ash	3.86	3.86	7.7	3.86	
Red lead	16.42	21.60	21.60	16.42	10.3
Zinc oxide	6.0	6.0	6.0	6.0	5.0
Fluorspar	5.5	5.5	5.5	5.5	5.5
Cryolite	5.0	5.0	5.0	5.0	
Barium carbonate					4.5
Boric acid					8.85

Discussion of this paper, *Bull. Amer. Ceram. Soc.*, **1,** 305 (1922). (*Chem. Abs.*, **16,** 4037 (1922); *Chem. and Ind.*, **41A,** 898 (1922); *Ceram. Abs.*, **3** [5], 120 (1924); *Chem. Abs.*, **18,** 1185 (1924); *Chem. and Ind.*, **43B,** 381 (1924).)

Danielson, R. R., and Souder, W. H.

CAUSES AND CONTROL OF FISHSCALING OF ENAMELS FOR SHEET IRON AND STEEL. *Jour. Amer. Ceram. Soc.*, **4,** 620 (1921).—*Data obtained:* This paper presents measurements of the following factors and properties and their influence upon fishscaling in the case of typical single- and three-coat enamels; time and temperature during melting of the frit; fusibility of the enamel; coefficient of expansion of the enamel, and of a variety of representative irons and steels up to 500°C (accurately about 0.1%); annealing the enamel coat after firing; chemical composition of the steels and irons; mechanical treatment (rolling, spinning, drawing, etc., of the stock); microscopic surface structure of

the stock; effect of chemical composition upon thermal expansion of enamel. The formulas of Mayer and Havas for computing the thermal expansion of enamel from its chemical composition cannot be relied upon. On the basis of these exhaustive tests, the following conclusions have been drawn as to the causes and the control of fishscaling. (*A*) *Causes:* (1) The cause of fishscaling lies in the difference of the coefficients of expansion of the enamel and the stock, that for steel being higher than for enamels so that the latter are under a compressive stress. The factors influencing this phenomenon are as follows: (*a*) composition of the enamel as affecting its coefficient of expansion; (*b*) overfiring, thus volatilizing those substances which tend to keep the coefficient high; (*c*) lack of annealing enameled ware, the enamel coating of which is a glass and should logically be treated as such. (2) Fishscaling is due secondarily to a number of factors which may affect the strength of the enamel or its adherence to the metal: (*a*) the physical condition of the surface of the metal as influenced by drawing, spinning, cold rolling, or other mechanical treatment; (*b*) composition of the glass as affecting its elastic strength; (*c*) underfiring, enamel not fused to metals; (*d*) cleanliness of the surface in regard to removal of drawing compounds, grease, etc. (*B*) *Remedies:* (1) (*a*) Adjusting the composition of the enamel so as to increase its coefficient, *e.g.*, by decreasing the boric acid content; (*b*) correct firing of the enamel to avoid unnecessary volatilization of such fluxes as soda and cryolite. (2) (*a*) Adjusting enamel composition to increase its strength; (*b*) correct firing to give proper adherence. (3) Treatment of metal to give best adhesion by (*a*) cold rolling or other suitable mechanical treatment of the untreated steel; (*b*) thorough cleaning. (*C*) *Summary:* Fishscaling can be absolutely controlled by one or all of the following methods: (1) by the development of an enamel with an expansion fitting the metal; (2) by annealing the enameled ware; (3) by treatment of the metal as cold rolling or some other method of working; (4) by developing an enamel with a wide range of compressional elasticity and applying this enamel to metal treated as indicated above. (*Chem. Abs.*, **16,** 150 (1922); *Chem. and Ind.*, **40A,** 891 (1921).)

Danielson, R. R., and Sweely, B. T.

RELATIONS BETWEEN COMPOSITION AND PROPERTIES OF ENAMELS FOR SHEET STEEL. *Jour. Amer. Ceram. Soc.*, **6** [10], 1011 (1923); *Sprechsaal*, **59,** 80 (1926); *Chem. Zentr.*, **1,** 2236 (1926).—Very little has been reported on the relations existing between enamel composition and the properties except the resistance to acids. In this investigation a study was made of the relation between enamel composition and such properties of the enamel as expansion, strength, and acid resistance, as well as the effect of the relative "fit" of the ground and cover coats, on resistance of the enameled ware to impact and to thermal shock. The work was done on fourteen ground coats and white cover enamels applied to 8-inch dinner plates. The latter were tested for resistance to impact, to thermal shock and to acetic acid. Determinations were made of the expansion and compression strength of the enamels before application to steel. (1) The replacement of boric oxide by sodium oxide in the enamels increased the coefficient of expansion. Fishscaling decreased with increase of expansion, due to increases of sodium oxide. (2) The compressive strength of the ground coats appeared to decrease with replacement of boric oxide by sodium oxide, although the reverse conditions occurred in the case of the cover enamels. (3) Impact on the parts of enameled ware not free to deflect, such as the curved corners at the bottom, gives a measure of the toughness of the enamel as applied on the steel. The resistance of the enamel on corners to impact apparently is a function of the inherent strength of the enamel rather than its "fit" on the ware. (4) For greatest resistance to thermal shock, the ware should be coated with a ground coat having a coefficient of expansion equal to or preferably greater than that

for the cover enamel. (5) Acid resistance, while dependent on the enamel composition is not affected in the same way for all enamels, resistance to acids decreased with replacements of boric acid by sodium oxide.

BATCH WEIGHTS OF GROUND COATS

	C-2	C-5	C-8	C-11	C-14	C-17	C-20
Feldspar	60	60	60	60	60	60	60
Boric acid	42.5	37.2	16.2				
Borax			24.3	41	33	24.6	16.4
Cryolite	11	11	11	11	11	11	11
Sodium nitrate		5.5	5.5	6.1	5.5	5.5	5.5
Soda ash		1.7			7.8	15.3	22.7
Fluorspar	4	4	4	4	4	4	4
Black cobalt oxide	1	1	1	1	1	1	1

BATCH WEIGHTS OF WHITE COVER ENAMELS

	B-1	B-4	B-7	B-10	B-13	B-16	B-19
Feldspar	50	60	60	60	60	60	60
Quartz	10						
Boric acid	39	37.2	20.1	3.01			
Borax			18.2	36.3	33	24.6	16.5
Cryolite	12	12	12	12	12	12	12
Sodium nitrate	2.75	5.5	5.5	5.5	5.5	5.5	5.5
Soda ash					6.1	13.6	21
Fluorspar	5	5	5	5	5	5	5

The enamels were milled in approximately 10-pound batches, with the following mill additions for approximately 7 hours.

Ground Coats		White Cover Enamels	
Frit	10 lbs.	Frit	10 lbs.
Clay	7.0%	Clay	7.0%
Borax	1.5%	Tin oxide	6.0%
Water	50.0%	Magnesium carbonate	0.5%
		Water	50.0%

(*Enamelist*, **1** [4], 23 (1924); *Chem. Abs.*, **17**, 3911 (1923); *ibid.*, **21**, 3722 (1927); *Chem. and Ind.*, **42A**, 1223 (1923).)

Danver, J. H.

MAKING MOTTLED OR COLORED ENAMELS. U. S. Pat., 1,001,511, Aug. 22, 1911.—This consists of fusing two or more portions of coloring matter of different colors with different batches of glass, grinding the resulting materials separately and mixing two or more of them with white or lighter colored enamel. (*Chem. Abs.*, **5**, 3898 (1911).)

Darchie, J.

ENAME LING LAVA. *La Céramique* [375], 145 (1919).—The lava of Volvic has been utilized, after being enameled, for many purposes including laboratory tables, hospital tables, baths, monuments, decorative purposes, etc. The lava is mined in blocks, sawed and trued to the required shape and the porous surface is filled with a special composition. The enamel is applied by dipping, spraying, or with a brush and the ware is then fired in muffle kilns. (*Jour. Amer. Ceram. Soc.* (Abs.), **2**, 917 (1919).)

Darrah, W. A.

PRACTICAL CONSIDERATIONS REGARDING ENAMELING FURNACES. *Bull. Amer. Ceram. Soc.*, **5** [2], 145 (1926).—A short review of the development of enameling is given. The salient points of enamels and enameling are very generally discussed. The prime objectives of commercial enameling are high quality and economy. Heat requirements

for successful enameling are enumerated and discussed. Various types of enameling furnaces are described, pointing out the advantages and limitations in the use of each. Some desirable furnace characteristics and fuel requirements are discussed. (*Ceram. Abs.*, **5** [3], 80 (1926).)

Dauch, Alan D.

ENAMELING FURNACE. U. S. Pat., 1,532,621, April 21, 1925.—An enameling furnace having in combination therewith a plurality of beams or members arranged in spaced relation within the furnace and racks consisting of a plurality of longitudinal sections provided with pins for supporting articles and detachably supported by said beams or members. (*Ceram. Abs.*, **4** [6], 165 (1925); *Chem. Abs.*, **19**, 1763 (1925).)

Dauch, A. D.

URGES FAIR FURNACE COMPARISON. *Ceram. Ind.*, **4**, 111 (1925).—Figures on sheet iron should be presented on the basis of gallons of oil per 100 sq. ft. of a certain gage sheet, or kw.-hr. per 100 sq. ft. on the same basis. The number of man hours per 100 sq. ft. should also be given. Another important point is the floor space occupied by the several types of equipment. (*Ceram. Abs.*, **4** [5], 126 (1925).)

Davidsen, M. J.

MANUFACTURE OF ENAMELED OBJECTS. British Pat. 248,514, Dec. 24, 1924.—A cement, rich in alumina and poor in silica and lime, is mixed with not more than 15% of sand or Portland cement, or both, sufficient water for setting being added. Objects made from the mixture are allowed to harden in air or water and subsequently enameled and fired in the usual way. (*Ceram. Abs.*, **5**, 385 (1926); *Chem. and Ind.*, **45B**, 542 (1926).)

Davidson, T. R.

CLEANING OF METAL ARTICLES PREPARATORY TO THE APPLICATION OF A COATING OF ENAMEL OR THE LIKE. British Pat. 16,554, July 18, 1913.—Concentrated sulphuric acid is used to carbonize the grease, and the pieces are then allowed to stand in water, where the diluted acid further cleans the articles. (*Chem. and Ind.*, **33**, 355 (1914).)

Davidson, T. R.

PICKLING METAL TO PREPARE IT FOR ENAMELING. U. S. Pat. 1,104,107, July 21, 1914; German Pat. 277,834, July 22, 1913.—Immersed in concentrated sulphuric acid at 90 to 150°, washed with water at 65°, and then at 100°. (*Chem. Abs.*, **9**, 1104 (1915); *ibid.*, **8**, 3102 (1914).)

Davis, H. E.

SOMETHING BETTER IN ENAMEL SMELTERS. *Chem. Met. Eng.*, **27**, 1210 (1922).—A description of a new type of enamel smelter, using oil as fuel. The general construction of the furnace and some data as to the cost of operation are given. (*Ceram. Abs.*, **2**, 64 (1923).)

Davis, Lawrence R.

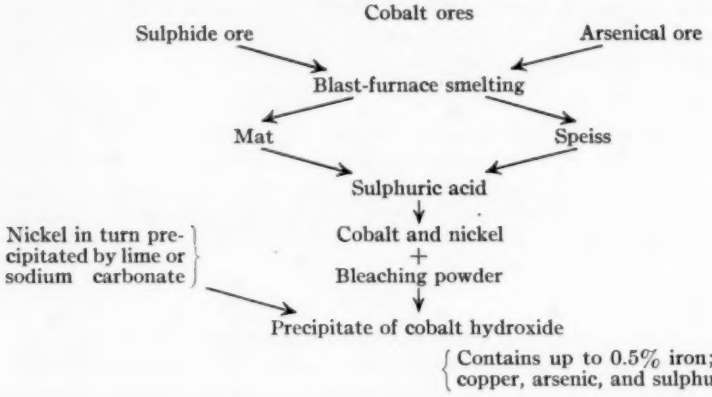
COATING APPARATUS. U. S. Pat. 1,347,256, July 20, 1920.—A combination with a spraying device, of a series of carriers for the articles to be coated, means for successfully moving the carriers into register with a spraying device, and controlling means for the spraying device adapted to shut off the spray automatically prior to the movement of a carrier into register therewith, with controlling means comprising a drive shaft for the carrier-operating means, a sleeve valve carried by the drive shaft at one end thereof, a

casing for the valve, and a conduit affording communications between the valve and spraying device. (*Jour. Amer. Ceram. Soc.* (Abs.), **3,** 772 (1920).)

Davis, N. B.

COBALT OXIDE. *Jour. Amer. Ceram. Soc.*, **3,** 322 (1920).—For many years the world's supply of cobalt came from the cobalt-silver deposits of Saxony. With the discovery and development of nickel deposits of New Caledonia, metallurgical processes were perfected for the separation of cobalt, and for some time prior to 1903 most of the world's supply came from these ores. Between 1903 and 1908 some cobalt oxide was produced in Missouri, but since 1908 the greatest source has been in Canada. The Canadian production now shows signs of decline but the deposits of Missouri are coming to the fore again. The annual consumption of cobalt oxide in the United States is approximately 240,000 pounds.

METALLURGY OF COBALT



The cobalt hydrate is heated at low temperature to form cobalto-cobaltic oxide which is black in color. By subjecting the black oxide to temperatures around 1000°C oxygen is driven off, and the resultant material is largely cobalt monoxide, gray in color. The uses of cobalt are (1) for the ceramic industry, (2) for the manufacture of cutting tools, and (3) for the preparation of driers for soya bean oil. *Future conditions:* The price prior to 1907 varied from $1.60 to $2.00 per pound (70% metal), but in 1907 it rose to $2.50 per pound. Up to 1915 an overproduction caused a decline in cost, reaching an average of 90 cents in 1915. Since 1915 the demand has increased the price to the present day quotation of $1.50 per pound. The world resources are limited in extent and the requirements of the various trades becoming greater, so there is every indication that the price of cobalt oxide will advance.

Davis, N. B.

DERRY FELDSPAR QUARRY. *Jour. Amer. Ceram. Soc.*, **5,** 294 (1922).—An outstanding development in feldspar at Buckingham, Quebec, where a large deposit of high-grade potash feldspar known as Derry Quarry has been opened up and placed on a shipping basis.

Davis, N. B.

THE PLASTICITY OF CLAY. *Trans. Amer. Ceram. Soc.*, **16,** 65 (1914).—A review of the theories of plasticity. The influence of colloids seems greatest. The bonding power

and shrinkage depend on size of grain, mixture of fine and coarse grains, and the nature and varieties of colloids of the emulsion class. (*Chem. Abs.*, **8**, 3708 (1914).)

Dawes, Edward L.

ENAMELING DEVICE. U. S. Pat. 759,351, May 10, 1904.—The combination of a standard, a frame oscillatingly mounted thereon, a support oscillatingly mounted upon the frame, and a lever connected to the frame and support for simultaneously imparting a compound sidewise and endwise movement to the support.

Dawes, E. S.

SOME EARLY EXPERIENCES IN ENAMELING CAST IRON. *Jour. Amer. Ceram. Soc.*, **6**, 234 (1923).—Review of the writer's experiences covering a period of forty-four years in the sanitary field.

***Dayton Porcelain and Enameling Co.**

COPPER-LINED DRIER AND QUENCHING BUCKET KEEP ENAMEL CLEAN. See *Ceram. Ind.* (this *Bibliography*, p. 57).

Decken, C.

IMPORTANCE OF POWDERED COAL IN ENAMEL WORKS. *Glashütte*, **43**, 1004 (1913).—The relative value of 3 varieties of charcoal and coal are discussed. (*Chem. Abs.*, **8**, 1194 (1914).)

Dees, C. W.

ENAMEL CLEANING COMPOUND. U. S. Pat. 1,568,323, Jan. 5, 1926.—An enamel cleaning solution formed by mixing the following ingredients consisting of approximately 5% of acetic acid, $12^1/_2$% ammonia, 25% pulverized rotten stone, and $57^1/_2$% water.

Degelman, W. C.

DEVICE FOR SUPPORTING BATH TUBS WHEN APPLYING ENAMEL. U. S. Pat. 588,404, Aug. 17, 1897.—In devices for supporting bath tubs when applying the enamel, the combination of a suitable frame, a tilting table supported thereby, tilting table having a seat adapted to engage a lug on the bottom of the bath tub, and means for securing lug within the seat.

Degelman, William C.

APPARATUS FOR ENAMELING BATH TUBS. U. S. Pat. 663,601, Dec. 11, 1900.—In a device for supporting bath tubs when applying enamel, the combination with a carriage, a tilting-fork mounted thereon, means for raising and lowering the fork on the carriage, and means on the fork for engaging a lug on the bottom of the bath tub.

***Delage, M.**

PROCESS OF ENAMELING IN ONE STAGE. See Woog, P. (this *Bibliography*, p. 341).

Deleuil, S. L.

ENAMELING METAL PLATES. French Pat. 456,959, Apr. 22, 1913.—The plates, after immersion in the bath, are freed from excess by rapid turning. (*Chem. Abs.*, **9**, 137 (1915).)

Denecke, W., and Meirling, Th.

USE OF CAST IRON IN THE CONSTRUCTION OF APPARATUS. *Apparatebau*, **38**, 97 (1926).—A discussion of the properties and constituents of cast iron and the effects of heat on them. (Illustrated.) (*Ceram. Abs.*, **5**, 269 (1926).)

Denk, Emil S.

METHOD OF MARKING ENAMELED WARE. U. S. Pat. 1,473,903, Nov. 13, 1923.—The method of marking enamelware, comprising coating the enameled surface over the area to receive the mark with tacky material, applying to the coating an enamel, again coating the coated surface partially or wholly with a tacky material, applying to the part so recoated an enamel, and treating the ware to render the composite mark permanent. (*Ceram. Abs.*, **3**, 36 (1924).)

Denk, E. S.

MACHINE FOR MARKING ENAMELED WARE. U. S. Pat. 1,544,135, June 30, 1925.—A machine for marking enameled ware, comprising a bed adapted to hold the ware, a drum mounted above the bed, an elastic die on drum, an unyielding coating roller mounted above bed and laterally of drum, a fountain in which roller runs, an elastic distributing roller mounted above and engaging coating roller, and means for moving drum to first engage die with coating roller and thereafter engage die with the ware on bed.

Denmead, W. Angus

HINTS ON EXPERIMENTAL ENAMEL MAKING. *Trans. Amer. Ceram. Soc.*, **16**, 445 (1914).—Notes from experience of D. in making enamels for coating reflectors, drawn steel tubing, castings, etc. For low temperature enamels, those maturing between 100° and 1000°C. (*Chem. Abs.*, **8**, 3711 (1914).)

***Denmead, W. A.**

EFFECT OF VARIATION IN THE COMPOSITION OF GROUND COATS FOR SHEET-IRON ENAMELS. See Danielson, R. R. (this *Bibliography*, p. 84).

Desaghre

ENAMEL FOR CAST IRON. *Br. d'inv.*, **56**, p. 118. (*Rept. der Tech. Lit.*, p. 272 (1823–53).)

Desgl., p. 44.

CONCERNING JAPANESE ENAMELS. (*Rept. der Tech. Lit.*, p. 142 (1879–1881).)

Desgl., p. 434.

A NEW ENAMEL. (*Rep. der Tech. Lit.*, p. 142 (1879–1881).)

***Detroit (Mich.) Stove Wks.**

REMARKABLE RECORD OF ONE MAN FURNACES. See *Ceram. Ind.* (this *Bibliography*, p. 56).

***Detroit Vapor Stove Co.**

FIRST CONTINUOUS ENAMEL PLANT. See Meadows, Albert (this *Bibliography*, p. 212).

THREE ROTARY ELECTRIC FURNACES ENAMEL 11,780 SQ. FT. TRIPLE COAT DAILY. See *Ceram. Ind.* (this *Bibliography*, p. 57).

Deutsche Stahhottich Ges.

SUBSEQUENT ENAMELING OF ROUGH PLACES AND WELDING OF ENAMELED ARTICLES. German Pat. 251,059, Sept. 5, 1911.—Borax is added as a flux before the heating. (*Chem. Abs.*, **7**, 235 (1913).)

Diamant, **20**, 755 (1898).

PREPARATION OF COLORED ENAMELS.—Opaque colored enamels are prepared by mixing transparent colored enamels with tin oxide added to the flux at the same time as the lead oxide, the metals being converted, on fusion, into silicates and borates. The fusing point of these bodies varies from about 1200°C for the true colored glasses, to 850 to 900°C for porcelain-biscuit enamels, and even lower in the case of enamels for glass painting and metal. For transparent enameling on glass, the impregnation method is practiced, chiefly for the yellow color imparted by silver, the oxide or chloride of which metal is mixed with 10 to 20 parts of an inert substance like clay, iron oxide, etc., previously exposed to a higher temperature than is required for the actual firing in order to prevent shrinkage and consequent imperfect coloration during the latter operation. After removal of the glass from the muffle, the loose superficial coating is brushed off and treated for the recovery of the superfluous (95% or so) silver compound. For the darker shades of yellow the use of antimony and silver can be replaced by silver and ocher; 1 part of silver chloride giving with 24 parts of yellow ocher a lemon yellow; with 18 parts of yellow and brown ocher a golden yellow; with 12 parts of brown and red ocher, an orange; and with 6 parts of red ocher a garnet-red coloration. (*Chem. and Ind.*, **18**, 145 (1899).)

Diamant, **35**, 485 (1913).

ADVANTAGES OF THE PORTABLE MUFFLE FURNACE IN GLASS, PORCELAIN, AND ENAMEL WORKS. (*Chem. Abs.*, **7**, 3003 (1913).)

Dichanz, G.

SECURING ENAMELED METAL PLATES TO EACH OTHER. German Pat. 286,774, Nov. 13, 1914.—The plates are screwed together with the use of screws in the threads of which enamel is placed, and afterward the plates are returned to the furnace and the enamel is fused again. (*Chem. Abs.*, **10**, 1587 (1916).)

Dicken, W., Wade, W., and Grimwade, L. T.

CONTINUOUS MUFFLE FURNACES OR KILNS. British Pat. 1805, Jan. 26, 1899.—The furnace is intended for the firing of pottery and enameled iron. The muffle is circular and within it is a turntable supported on rollers, and capable of being turned from the outside. The goods to be fired are placed upon this table. The fire hole is on the opposite side to the opening into the muffle. As it is only necessary to have one opening for the introduction and removal of the goods, the fire can be made to play all around the muffle. (*Chem. and Ind.*, **19**, 146 (1900).)

Diederichs, William J., and Hayes, Anson

PROCESS FOR TREATING IRON. U. S. Pat. 1,574,376, Feb. 23, 1926.—The process for the heat treatment of castings from white cast iron which consists in (1) subjecting the casting to a temperature above the critical temperature of the material for a period of from 15 minutes to 5 hours or more but only until the iron carbide present is practically all absorbed in the solid solution, which means that in irons of commercial composition the combined carbon is reduced to approximately 0.9%; (2) cooling the casting to a lower temperature in the neighborhood of the critical temperature; and (3) cooling the casting at a rate not less than about 7°C per hour. (*Ceram. Abs.*, **5**, 117 (1926).)

Diederichs, William J., and Hayes, Anson

PROCESS FOR TREATING IRON. U. S. Pat. 1,574,377, Feb. 23, 1926.—The process for the heat treatment of castings from white cast iron which consists in (1) subjecting the casting to a temperature above the critical temperature of the material; (2) cooling

the casting to a point considerably below the original critical temperature; (3) reheating the casting to a sufficient temperature to allow chemical and structural changes to progress; and (4) cooling the casting to a temperature sufficiently low that chemical and structural changes cease. (*Ceram. Abs.*, **5,** 118 (1926).)

De Dietrich et Cie.

ENAMELING. British Pat. 165,785, June 22, 1921.—A current of purified gas is caused to ignite on entering the enameling chamber, and ignition continues in direct contact with the articles to be enameled. In the gas generator one portion of the gas is drawn off and traverses a condenser, which retains the gas tar, oils, and any liquid or solid distillation product, and another portion is obtained by the gasification of undercarbonized coke and washed after deposition in two chambers of a very fine cinder. The two portions of gas are then reunited in a disintegrator, which also removes the last traces of oil by means of gas tar. The gases pass through a series of safety strainers and, shortly before entering the enameling chambers, combustion commences owing to the introduction of a current of warm air. Combustion is then started and is completed in the enameling chambers. (*Ceram. Abs.*, **1,** 118 (1922); *Chem. Abs.*, **16,** 473 (1922); and *Chem. and Ind.*, **41A,** 860 (1922).

Dingler's polytech. J., **23,** p. 415.

MANUFACTURE OF ENAMELED DIALS FOR WATCHES. (*Rept. der Tech. Lit.*, p. 272 (1823–1853).)

Dingler's polytech. J., **59,** p. 76.

ENAMEL AND GLASS FLUX FOR APPLICATION ON METALS. (*Rep. der Tech. Lit.*, p. 272 (1823–1853).)

Dingler's polytech. J., **167,** p. 318; *Centrabl.*, p. 486 (1863.)

TESTING OF ENAMEL OF IRON VESSELS FOR LEAD. (*Rep. der Tech. Lit.*, p. 306 (1854–1868).)

Dingler's polytech. J., **192,** p. 511; *Dt. Ind. Z.*, p. 228 (1869); *Centrabl.*, p. 615 (1869.)

INVESTIGATION OF WHITE GLAZES OF IRON VESSELS IN HYGIENIC REFERENCE. (*Rep. der Tech. Lit.*, p. 405 (1869–1873).)

Dingler's polytech. J., **198,** p. 135; *Centrabl.*, p. 30 (1871.)

NOTICE CONCERNING IRON ENAMELING. (*Rep. der Tech. Lit.*, p. 405 (1869–1873).)

Dingler's polytech. J., **203,** p. 499.

ENAMEL FOR COPPER COOKING VESSELS. (*Rep. der Tech. Lit.*, p. 405 (1869–1873).)

Dithridge, Edward

ENAMELING TABLE FOR BATH TUBS. U. S. Pat. 658,833, Oct. 2, 1900.—The combination with a tilting enameling table, of links or rods secured thereto, and a tub having above its bottom projections arranged to be engaged by the rods.

Dithridge, Edward

MANUFACTURE OF ENAMELS. U. S. Pat. 684,979, Oct. 22, 1901.—In enamel-comminuting apparatus, a water-tank, a perforated vessel or receiver within the water-tank having a spout leading outwardly from it and a screen upon which the spout discharges.

Dithridge, Edward

ENAMELING FORK FOR BATH TUBS. U. S. Pat. 700,021, May 13, 1902.—An enameling fork having pivoted side supports for the tub mounted thereon, and end clamping devices for the tub arranged to engage the side supports.

Dodge, H. H.

FURNACE FOR ENAMELED ARTICLES, ETC. U. S. Pat. 1,570,340, Jan. 19, 1926.—A furnace as characterized, comprising oppositely disposed parallel side walls, a lower flat hearth wall, and an upwardly arched top wall, continuously inwardly thickened lateral portions formed on the lower sides of each side wall full length thereof, continuous vertical baffle members disposed longitudinally of the furnace along the inner edges of the inward portions whereby to form with the inner faces of the side walls combustion chambers; the side walls being provided with burner openings extending transversely therethrough and in communication with the combustion chambers, an outlet flue disposed longitudinally through the side walls in the bottom portions thereof, the bottom portions of the side walls being provided with lateral flues communicating from the interior of the furnace to the outlet flue on the hearth, and vertical baffle members arranged longitudinally in the furnace in front of the lateral flues and on the hearth-wall to provide work-supporting members. (*Ceram. Abs.*, **5,** 164 (1926).)

***Donauer, Max**

ENAMELED APPARATUS FROM A CHEMICAL ENGINEERING STANDPOINT. See Poste, E. P. (this *Bibliography*, p. 248).

Donauer, Max

USES FOR INDUSTRIAL ENAMELED EQUIPMENT. *Chem. Met. Eng.*, **25,** 1015 (1921).—Glass enameled units, 25 to 7500 gallons serve three general uses, food, pharmaceutical, and chemical. Advantages over other containers are discussed. (*Ceram. Abs.*, **1,** 148 (1922); *Chem. Abs.*, **16,** 809 (1922).)

Dormoy, A.

ENAMELING METAL. British Pat. 18,350, Aug. 26, 1898.—The apparatus consists of a closed enameling cage, with glazed sides or view holes, the upper part of which is furnished with a tightly fitting sliding door for the introduction of the articles to be enameled, and with an arrangement of hopper, brush, and sieve, for distributing the enamel powder. Within the cage is a support for the articles to be enameled, which can be oscillated or rotated through a considerable angle round a horizontal axis, while by means of an internal shaft and mechanism rotation can be given to the table supporting the goods. When the support is inclined, electromagnets come into action automatically, so as to hold the objects on the inclined table. Every part of the object can thus be covered with the enamel. The surplus enamel collects in a hopper at the bottom of the cage, and can be recovered and used again. A slight diminution of pressure inside the cage insures that none of the fine dust shall escape, and the workman is thus completely protected. (*Chem. and Ind.*, **18,** 761 (1899).)

Dormoy, A.

MEANS OF AND APPARATUS FOR MECHANICALLY ENAMELING METAL. British Pat. 6922, Dec. 12, 1900.—The distribution of the enamel powder over the heated objects is effected in a cage, in which a slight vacuum is maintained for the protection of the workman, and the withdrawal of the finest dust. Windows in the cage enable the operator to manipulate the objects, which are supported on a plate capable of being moved

from outside so as to receive evenly the falling enamel powder which is shaken from sieves by electric beaters. (*Chem. and Ind.*, **20**, 364 (1901).)

Dreissen, Cl. G.

ENAMELS AND CERAMIC PIGMENTS. *Poly. Weekblad*, Nos. 5, 6, 8 (1918); *Chem. Weekblad*, **16**, 865 (1919).—A review is given of the structure of enamel, then of the influence of the components, as to their physical and chemical properties. The following components were treated: feldspar, quartz, fluorspar, clay, borax, boric acid, cryolite, and other F compounds, Mn, Sn oxide, Sb oxide, $NaSbO_3$, titanic acid, Ti oxide, ZrO_2, NiO, CoO, KNO_3 and K_2O. In conclusion the pigments used in ceramics are also discussed: blue, red, green, rose, and yellow, and an indication is given of what each is composed. (*Chem. Abs.*, **13**, 2115 (1919).)

Dressler, C.

ENAMELING BOTH SIDES OF FLAT METAL ARTICLES, ETC., IN TUNNEL KILNS. U. S. Pat. 1,552,475, Sept. 8, 1925.—The method of enameling both sides of flat articles in a tunnel kiln of the muffle type by means of a convection current circulation of the kiln chamber and radiant heat, which consists in supplying heat at substantially the same rate to each side of the article by setting up a convection current circulation of the kiln atmosphere in directions transverse to the length of the kiln while holding the articles in a horizontal position in the kiln chamber with their upper sides exposed to radiant heat from the roof of the kiln and their lower sides exposed to radiant heat from the hot kiln walls at the sides of, and beneath, the articles. (*Ceram. Abs.*, **4**, 299 (1925); *Chem. Abs.*, **19**, 3576 (1925); and *Chem. and Ind.*, **44B**, 882 (1925).)

Dubois, V., and Stewart, W. C.

ENAMELING SHEET METALWARE. U. S. Pat. 498,207, May 23, 1893.—An improved process of enameling articles of iron or steel ware which consists in applying a foundation or ground coating thereto; in firing the ground coating; applying an enamel coating of any desired color; drying the enamel coating; applying a volatile liquid to the enamel coating; volatilizing or evaporating the volatile liquid, whereby variegated or mottled spots will be formed on the enamel coating; and finally in firing the enamel coating.

Dueker, W. H.

CASTINGS GOOD SPONGES. *Enamelist*, **2** [1], 18 (1924).—Rusty castings absorb moisture and give rise to black specks, bubbles, etc., when enameled. This condition was remedied by drying the castings after they were sandblasted, and applying the enamel to the casting while it was yet warm.

Duesing, F. W.

FOUNDATIONS FOR HEAT-TREATING COMMERCIAL ALLOY STEELS. *Mitt. Kaiser-Wilhelm Inst. Eisenf.*, **6**, 71 (1925).—For a number of construction steels, containing, respectively, Mn, Mn–Si, Ni, Cr–Ni, and Cr as alloying elements, D. investigated the transition phenomena in the critical range. Both the thermal analysis method and the determination of the hardness as a function of the quenching temperature were used. For a proper heat treatment the knowledge of the Ac_3 point is indispensable. This point cannot be properly located on the heating curve. On the other hand the quench temperature-hardness curve gives reliable results. Mechanical tests made on a Cr–Ni steel confirmed the results of the quench-hardness method. The effect of annealing (heating of test bars for 90 minutes at temperatures ranging from 600 to 1000°, followed by cooling for 48 hours in ashes) on the mechanical properties led to the conclusion that

a little below Ac, the steels were in their softest condition. Photomicrographs of steels thus annealed showed the cementite to be spheroidized. A considerable amount of work was done on the effect of different methods of quenching and tempering on the mechanical properties and microstructure of the above-mentioned alloy steels. The results are represented in numerous tables, cuts and photomicrographs (at 500 diams.). Dynamic tensile tests by the method of Koerber and Simonson showed that invariably more energy is required to break the specimens than in the ordinary static tensile test machines. The article is concluded by a comparative study of the relation between (1) Brinell hardness, (2) shore hardness, (3) Wust-Bardenheder hardness, and (4) tensile strength. (*Ceram. Abs.*, **5**, 14 (1926).)

Dullo

PROCESS FOR SMELTING GLAZES. *Centrabl.*, p. 814 (1865); (*Rep. der Tech. Lit.*, p. 306 (1854–1868)).

Dunlap, William A.

ENAMELING METAL. U. S. Pat. 679,300, July 30, 1901.—A thin finish coat is applied to a fired ground coat and while this is still wet, a second thin coat of a contrasting color is applied.

Dunlap, William A.

ENAMELED WARE. U. S. Pat. 868,078, Oct. 15, 1907.—A vessel having in combination body and bottom portions secured together with the joint between the parts opening upwardly, the portions of the body above and adjacent to the plane of connection being bent to form an angle to the axis of the body, greater than the angle of the body to the axes, whereby the flow of enamel is retarded and permitted to fill the joint.

Dupont, P.

ENAMELING METAL ARTICLES AND FURNACE THEREFOR. British Pat. 114,618, Feb. 14, 1918.—A bath or other article to be enameled is placed in a furnace of similar shape, composed of very porous refractory material, covered externally with a metal casing which is separated from it by a very narrow space. The furnace is heated by a mixture of gas and air preheated by the waste gases and injected into the space between the refractory material and the casing, and ignited on the inner surface of the refractory material by means of a series of independent burners. The products of combustion circulate between the refractory material and the article to be heated, and pass through two discharge passages, one in the base and the other in the cover of the furnace, to a supplementary furnace which is used for preheating the articles to be enameled. The cover of the furnace is also of porous refractory material, but the angles are provided with pieces of nonporous refractory material. The refractory material is rapidly raised to incandescence and when the article to be enameled has reached the requisite temperature, the cover is removed and the surface of the article is covered with powdered enamel. In an alternative arrangement, the refractory material may be much thinner and nonporous; it is then preferably strengthened by a metal casing and is heated by a series of burners, the flames from which burn in the space between this casing and an outer casing. (*Chem. and Ind.*, **37A**, 700 (1918).)

Dupont, Paul

MACHINE FOR MECHANICALLY ENAMELING BATHS OR OTHER METAL OBJECTS. U. S. Pat. 710,443, Oct. 7, 1902.—A machine for spreading enamel upon the inside of baths, and other hollow objects, comprising, in combination, a chamber having a plurality of sides adapted to be raised and one side which is fixed, a screen comprising screen-bands separated by solid portions, compartments, above the screens, strikers adapted

to strike the walls of the compartments, cams arranged to operate the strikers whereby a fine powder of enamel is spread upon the objects to be enameled, a rotary and pivoted table for carrying the object, and means actuated from without the chamber for giving the table a variable motion.

Dupont, P.

ENAMELING BATH TUBS. German Pat. 269,524, Sept. 26, 1912.—Heating of the tub is effected by electrical means, constituting the tub as a short circuit for the secondary of a static transformer. (*Chem. Abs.*, **8**, 2469 (1914).)

Dupont, P.

ENAMELING AND ANNEALING FURNACE. U. S. Pat. 1,335,279, Mar. 30, 1920.—The furnace described is particularly designed for enameling bath tubs, although it may be modified in shape to be suitable for other articles. It comprises a receptacle conforming in shape to that of a bath tub, the walls of which are lined with a porous refractory. A cover of similar material is provided. A mixture of fuel gas and oxygen is forced through the porous walls and ignited. These walls become incandescent and impart their heat to the tub. When the proper temperature has been reached the cover is removed and the enamel sprinkled over the surface of the tub. As the tub is meanwhile being subjected to the furnace heated the powdering can be effected in one operation. (See British Pat. 114,618 of 1918.) (*Jour. Amer. Ceram. Soc.* (Abs.), **3**, 600 (1920); *Chem. and Ind.*, **37A**, 700 (1918); *ibid.*, **39A**, 366 (1920).)

Durand-Morimbau

ENAMEL FOR VARIOUS METALS. *Br. d'inv.*, **46**, 225. (*Rep. der Tech. Lit.*, p. 272 (1823–1853).)

***Ebbefeld, C.**

SHRINKAGE IN WHITE AND GRAY IRON. See Bardenheder, P. (this *Bibliography*, p. 13).

Ebeling, Charles W.

ENAMELING TABLE. U. S. Pat. 996,226, June 27, 1911.—An enameling apparatus comprising a tiltable bed plate, a gear wheel rotatable upon the bed plate, means for rotating the gear wheel, a base member mounted upon the gear wheel and rotatable therewith; an apron mounted upon the base member, and means for lowering ware into the inclosure constituted by the apron and for elevating it above the inclosure.

Ebinger, David A.

WASHBASIN. U. S. Pat. 1,517,414, Dec. 2, 1924.—A device comprising a basin, a vent pipe rising centrally therefrom, a manifold adjustably carried by the vent pipe and having a soap container associated therewith, and means for introducing water into the manifold. (*Ceram. Abs.*, **4**, 34 (1925).)

Ebright, H. E.

FUNCTIONS OF RAW MATERIALS USED IN MANUFACTURE OF VITREOUS ENAMELS FOR CAST IRON AND SHEET STEEL. *Enamelist*, **2** [4], 5; [6], 8; [8], 18; [10], 5 (1925).—(*A*) *Refractories:* (1) feldspars, (2) various forms of silica. (*B*) *Fluxes:* (1) borax and boric acid, (2) soda ash, (3) sodium nitrate, (4) cryolite, (5) sodium silico-fluoride, (6) calcium carbonate, (7) fluorspar, (8) magnesium carbonate, (9) potassium carbonate, (10) barium carbonate and barium hydroxide, (11) barium fluoride, (12) zinc oxide, (13) lead compounds, (*a*) red lead, (*b*) litharge, (*c*) white lead. (*C*) *Opacifying agents:* (1) antimony oxide and compounds, (2) tin oxide, (3) sodium metantimonate, (4) arsenic oxide, (5) bone ash, (6) fluorides, (7) titanium oxide, (8) spinels, (9) zirconium com-

pounds. (*D*) *Metallic agents in ground-coat enamels for sheet steel:* Some of the combinations used are: (1) 0.4% cobalt oxide, 0.75% nickel oxide; (2) 0.5% cobalt oxide, 1.5% manganese dioxide; (3) 0.3% cobalt oxide, 0.4% nickel oxide, 0.3% manganese dioxide.

Ebright H. E.

DRYING OF WET-PROCESS ENAMELS. *Enamelist*, **5** [1], 29 (1927).—For fast drying it is highly important that air pressure or pressure of circulation is not brought directly on the enamel surface to be dried. It has been found from commercial experiment heating from below either with air under fan pressure at a temperature of 170 to 200°F or with radiated bottom heat at a temperature of around 350°F is highly essential for the speed of drying along with quality and finish of enamel that is demanded today.

Edson, S. P.

EARLY HISTORY OF ENAMELING AND OBSERVATIONS ON FISHSCALES. *Enamelist*, **3** [2], 9 (1927).—Standard ground frits can be adjusted and used on any grade of sheet steel, and in any factory without danger of fishscaling, if furnace temperature, atmosphere, and time are correct.

Ehrenberg, P.

PLASTICITY, ESPECIALLY OF BARIUM SULPHATE. *Z. angew. Chem.*, **24,** 1957 (1911).—Review of literature, giving various contending views as to causes of plasticity. Bibliography. (*Chem. Abs.*, **6,** 797 (1912).)

Eidler, M.

MATTING ENAMELED IRON PLATES. German Pat. 235,073, May 15, 1910.—Enameled ware is covered with a lukewarm, concentrated, aqueous solution of magnesium sulphate, and after drying, it is heated again in the furnace up to 800° in order to fire the finely divided salt mass in the softened superficial enamel. The surfaces are used for writing upon. (*Chem. Abs.*, **6,** 1828 (1912).)

Eisen Ztg., **4,** 133.

ENAMEL. (*Rep. der Tech. Lit.*, p. 119 (1882–1884).)

Eisenlohr

ENAMEL COLORS RESISTANT TO ACIDS AND THEIR TESTING. *Sprechsaal*, **59,** 645 (1926); *Chem. Zentr.*, [II], 2472 (1926).—The resistance to acids of enamel colors does not increase with increasing SiO_2 content. All enamels containing between 1.3 and 2.0% SiO_2 to 0.7 PbO + 0.3 Na_2CO_3 are resistant to acids. Acid-resistant enamels give up only 0.1 to 0.01 as much to acids as ordinary enamels. They are tested with 3% hydrochloric acid in which the baked enamel is immersed for at least five hours. This treatment should not detract from the brilliancy of the enamel, even when it is thick. (*Chem. Abs.*, **21,** 4039 (1927).)

Elam, C. F.

ORIENTATION OF CRYSTALS PRODUCED BY HEATING STRAINED IRON. *Iron and Steel Inst.*, Sept., 1925.—Square etching pits with a diagonal in the direction of straining are frequently obtained in large crystals produced by annealing strained iron. The crystal axes, relative to the direction of straining, of ten crystals were determined by X-ray analysis and the orientation was shown to be varied. Only two crystals showed cubic etching pits, and in both of these the surface of the strip was parallel to a cubic (100) plane in the crystal. Crystals of other orientation only showed pitting after prolonged etching; it should therefore be possible to pick out these crystals in which a

(100) plane lies in or near the plane of section. (*Ceram. Abs.*, **5**, 46 (1926); *Chem. and Ind.*, **44B**, 806 (1925).)

Electrical World, **79**, 286 (1922).

OPERATING COSTS OF ELECTRIC FURNACE FOR BAKING VITREOUS ENAMEL.—Production was increased and costs were reduced by substituting electric for oil-fired enameling furnaces. Detailed figures are given. (*Ceram. Abs.*, **1**, 168 (1922); *Chem. Abs.*, **16**, 997 (1922).)

***Elyria Enameled Products Co.**

ENAMEL-LINED APPARATUS. See Jones, Chester H. (this *Bibliography*, p. 163).

ENAMELED PRODUCTS RESEARCH LABORATORY. See Poste, E. P. (this *Bibliography*, p. 237).

Emley, W. E.

MEASUREMENT OF PLASTICITY OF MORTARS AND PLASTERS. U. S. Bur. Stand., *Tech. Paper*, No. 169 (1920).—A historical outline is given of the work of the Bureau of Standards on this subject since 1909. The methods thus far tried are: (1) measurement of colloidal content, (2) measurement of viscosity, (3) compressive method, (4) range of plasticity, (5) rate of drying, (6) Carson blotter test, and (7) present instrument for measuring plasticity. The plasticity of a plaster depends on (1) the ability of the material to retain its water against the suction of the surface to which it is applied; (2) the more plastic a material the less is the amount of work required to spread it. The present machine was designed to duplicate the action of a plasterer. This machine is described in the paper. (*Chem. Abs.*, **14**, 3143 (1920).)

Emmerling, O.

ENAMELS. *Ber.*, **29**, 1549.—E., on examining a French enamel characterized by its extreme whiteness, found, in addition to silica and potash, quantities of lead oxide (52.51%) and of arsenic acid (3.74%) but no oxide of tin, the usual coloring matter, or boric acid. The enamel was easily attacked by dilute acids and was therefore, in E.'s opinion, unsuitable for use. (*Chem. and Ind.*, **15**, 544 (1896).)

Enamelist, **1** [1], 8 (1923).

GOOD IDEA FOR PICKLE ROOM.—Describes the use of Marco Quick-Test Capsule in testing pickle acid.

Enamelist, **1** [2], 7 (1923).

WET PROCESS VS. DRY PROCESS.—*Test I.* The test was made using three standard gas ranges. One oven was equipped with a wet-process front, the second with dry-process No. 1, and the third with dry-process No. 2. Grease was rubbed on sides and top of fronts, also on cross-strips when thermometer in oven stood at 250°, 300°, 350°, 450°, and 550°. With the thermometer showing 350° in the oven all fronts crazed on the cross-strips. None of the castings showed any signs of crazing at other points. These fronts had no liners in the cross-strip. A damp cloth was applied to the top and sides of all castings at 250°, 300°, 350°, 400°, 450°, 500°, 550°, and 600°. The result is as follows: dry-process No. 1 crazed at 450°; dry-process No. 2 crazed at 550°; and wet process did not craze at 600°. *Test II.* Three small castings were enameled as above and placed in the oven of a standard gas range equipped with a heat regulator for 30 minutes. The castings were then removed and each wiped with a damp cloth. The first test was made at 250°. This procedure was repeated, increasing the temperature of the oven 50° each time, until all three of the castings failed. Average results of three

separate runs: wet-process castings broke down at 406°; dry-process No. 1 castings broke down at 325°; and dry-process No. 2 castings broke down at 383°.

Enamelist, **1** [3], 4 (1923).

AUTOMATIC ENAMELING.—Continuous methods of pickling, drying, spraying, and firing are described.

Enamelist, **1** [4], 12 (1924).

TECHNICAL CONTROL OF ENAMELS.—Describes method of control for soda ash and borax. *Soda ash:* The percentage of Na_2O in the soda ash is determined by titrating a sample dissolved in water with $N/2$ hydrochloric acid. The ratio of 58.5 (percentage of Na_2O in soda ash) to the value obtained from the titration gives a factor for the amount of soda ash to be used. *Borax:* The percentage of Na_2O is determined by titrating a sample dissolved in water with $N/2$ hydrochloric acid. The solution is then boiled for about 15 minutes, 100 cc. of glycerine added, and then titrated with $N/2$ sodium hydroxide using phenolphthalein as an indicator. (Methyl orange was used in the hydrochloric acid titrations.) A blank should be run by titrating the glycerine with $N/2$ sodium hydroxide. The amount required for the blank titration is subtracted from the first sodium hydroxide titration mentioned. Then $\frac{52.88\ (\%\ Na_2O + \%\ B_2O_3 \text{ in borax})}{\%\ Na_2O + \%\ B_2O_3 \text{ (as found in sample)}} = \text{factor}$. This factor should then be used in correcting the amount of borax to be used in the batch.

Enamelist, **1** [7], 5 (1924).

INTERESTING PIECE-WORK DATA.—In this particular plant the following rates are in force: *Dipping:* dipper, 22¢ per 100 sq. ft., helper, 18¢ per 100 sq. ft.; *spraying:* one side only, 17¢ per 100 sq. ft., two sides, 25¢ per 100 sq. ft.; *firing ground coat:* fireman, 30¢ per 100 sq. ft., helper, 26¢ per 100 sq. ft. *Firing white:* electric 4 ft. x 10 ft. furnace with double fork; burner, 24¢ per 100 sq. ft., two helpers, 20¢ per 100 sq. ft. Single fork 3 ft. 8 in. x 9 ft. oil-fired furnace; fireman, 30¢ per 100 sq. ft., helper, 24¢ per 100 sq. ft. Statement of cost distribution as compared to sales: sales to direct labor, material, and overhead expense 0.81%; sales to profits 17.0%; sales to productive labor 19.0%; sales to nonproductive labor 12.0%; sales to raw materials and supplies 25.0%.

Enamelist, **1** [8], 13 (1924).

MORE PIECE WORK DATA.—Work is largely confined to ordinary stove parts and is divided into classes depending upon the size of the piece.

Class 1 $2^1/_2$ sq. ft. and over.
Class 2 $1^1/_2$ to $2^1/_2$ sq. ft.
Class 3 1 to $1^1/_2$ sq. ft.
Class 4 $^1/_2$ to 1 sq. ft.
Class 5 Under $^1/_2$ sq. ft.

(1) Dippers			(2) Spraying	(3) Ground Coat			(4) White	
Dipper per M	Helper per M	Class	Sprayer per M	Fireman per M	Helper per M	Class	Fireman per M	Helper per M
$6.30	$4.40	1	$5.60	$6.25	$4.45	1	$5.80	$4.25
4.00	2.80	2	3.30	4.75	3.75	2	4.60	3.60
3.00	2.10	3	2.70	3.10	2.45	3	2.85	2.30
2.60	1.80	4	2.50	2.25	1.70	4	2.00	1.55
2.40	1.70	5	2.00	2.00	1.60	5	1.75	1.45

Enamelist, **1** [9], 11 (1924).

BONUS VS. PIECE PRICE. *I. Cast Iron. Sandblasting:* 55¢ per hour plus 10¢ per 100 over 1500 lbs.; helper, 40¢ per hour. *Spraying:* 25¢ per hour plus 10¢ per 100 over 1500 lbs.; $2.00 per week bonus if no time is lost. *Firing:* 50¢ per hour, plus 10¢ per

100 over 1500 lbs. *II. Sheet Steel. Dipping:* 25¢ per hour, plus 20¢ per 100 sq. ft. over 750 sq. ft. *Spraying:* Same as dipping. *Firing:* 50¢ per hour, plus 20¢ per 100 sq. ft. over 800 sq. ft. *Brushing:* (one girl) 25¢ per hour, plus 10¢ per 100 ft. over 1500 lineal ft.; (two girls) 25¢ per hour, plus 10¢ per 100 ft. over 2000 lineal ft.

Enamelist, **1** [10], 7 (1924).

NEW ENAMELING PLANT OF THE AMERICAN RADIATOR CO. Description of plant.

Enamelist, **1** [10], 10 (1924).

CONTINUOUS ELECTRIC FURNACE.—Description of furnace developed by C. C. Armstrong.

Enamelist, **2** [1], 6 (1924).

COMPARATIVE COSTS OF GAS AND COAL.—(American Gas Association Data.) Gas furnace of standard 4 x 10 foot working chamber, intermittent type, open furnace, without muffle. Coal furnace of standard 4 x 10 foot working, coal fired, using full Carborundum muffle.

COMPARISON OF FURNACE COSTS

	Cost per Hour	
	Coal	Gas
Fuel	$0.53	$1.18
Power	0.00	0.10
Labor	.47	0.00
Furnace	.07	.02
Loss of production	1.50	0.00
Overhead expense	.23	0.00
Interest, etc.	.14	.14
Miscellaneous	.40	0.00
Special	1.40	
	$4.94	$1.44
Average hourly production (sq. ft.)	332	425
Cost per 100 sq. ft. of ware enameled	$1.50	$ .34

Enamelist, **2** [1], 26 (1924).

SAVING SCRAP.—Cost for removing enamel with muriatic acid was $0.0587 per sq. ft. for material pickled eight hours and $0.0645 for material pickled twelve hours. The parts recovered were entirely suitable for enameling and little difference could be noted between these pieces when enameled and the regular stock.

Enamelist, **2** [2], 13 (1924).

INSULATION OF ENAMELING FURNACES.—Data and charts are given to show that Sil-O-Cel brick reduces heat losses.

Enamelist, **2** [5], 6 (1925).

ABSTRACTS OF ENAMEL PAPERS SUBMITTED FEBRUARY, 1925 (ENAMEL DIVISION).—Short abstracts of papers read at this Meeting. Abstracts from original papers will be found under *Jour. Amer. Ceram. Soc.* references.

Enamelist, **2** [7], 5 (1925).

SAVING SCRAP.—Discusses the property of certain organic compounds in reducing the action of acid on steel. Formaldehyde was found to be the most effective. One per cent will reduce the action of muriatic acid 90%. During 1923, 5000 pieces were treated by above method and re-enameled. Seventy-six per cent of the re-enameled pieces were first, 16% came out seconds, and 8% jobs.

Enamelist, **2** [9], 22 (1925).

STEEL BLISTERS OUTSIDE AND IN.—Photographs of several cases of blistering are used showing gas pockets as the cause. Pickling sometimes shows up this hidden trouble, but proper degasification of the metal at the open hearth is the best insurance against this blister.

Enamelist, **2** [10], 22 (1925).

NEW CONTINUOUSLY FIRED SEMIMUFFLE ENAMELING FURNACE.—*Advantages:* (1) lower temperature can be carried in the combustion chamber, (2) saving of fuel, (3) lower furnace maintenance, (4) small furnace volume, (5) hearth is of much longer life, (6) difficulties in firing ground coat have been eliminated.

Enamelist, **3** [3], 6 (1925).

ENAMEL MAKING COST.—The following illustrates the items of cost that should be considered in figuring costs of smelting a high quality steel ground coat.

Material cost (including smelter losses)	$0.07
Freight and handling charges	0.001
Labor	0.01
Labor overhead and supervision	0.01
General overhead	0.02
Fuel	0.005
Maintenance	0.001
Equipment and investment	0.0055
Total cost per pound	$0.1225

Enamelist, **3** [4], 12 (1926).

INCREASING POPULARITY OF ENAMELED KITCHENWARE.—Report of survey shows that use and interest by consumer and dealer is greatly increasing. It was shown that enameled ware has come definitely and permanently into "its own" again.

Enamelist, **3** [9], 18 (1926).

CAST-IRON ENAMELING INSTRUCTIONS.—The following directions were taken from a German catalog: (1) *Cleaning:* anneal at red heat; remove rust and dirt by brushing; rinse in boiling soda solution (2 lbs. soda in 25 gallons water); dry. A thin layer of soda will prevent rust formation. Acid pickling has a bad effect on the subsequent enameling process for cast iron. (2) *Enameling:* ground enamel should have viscid consistency and the casting is either dipped into it, or the enamel poured with a trowel or ladle over the iron where it will spread in a layer of uniform thickness. The casting is quickly wiped off and then heated to 800°C for 3 to 4 minutes. (3) *Ground coat No. 2:* should have a rough and mat appearance; prepared with covering enamel, by wiping or dabbing off the casting with a moist sponge and then dipping into a ground glaze mixed with water or pouring the latter with a ladle; allowed to drip and then left to dry. (4) *Covering enamel:* allowed to dry about 10 hours so that it will not flake off in firing; fired for 5 to 7 minutes in a muffle at 800°C.

Enamelist, **3** [10], 32 (1926).

FUEL OIL DATA.—Temperature to which different oils must be heated for best results:

°Bé	°F
24–30	80–100
20–24	100–140
17–20	140–160
15–17	180–190
14–16	200–220
11–13	220–240

Enamelist, **4** [1], 7 (1926).

GRAINING MACHINES, LATEST DEVELOPMENT FOR BIG PRODUCTION OF IMITATION WOOD FINISHES IN PORCELAIN.—Short description of automatic machine manufactured by the Oxford Varnish Corporation. The machine travels at the rate of 40 feet per minute and the largest stove parts are approximately 4 feet long. Figuring that the machine is only operated at 50% of its efficiency, five pieces per minute or 300 per hour would be obtained.

Enamelist, **4** [1], 8 (1926).

ANNEALING PORCELAIN PARTS PROVES INTERESTING.—Answers to letters on this question. R. C. PURDY: Enamel is melted in place and is not subjected to strains, in its formation, which can be relieved by annealing. R. R. SHIVELY: Annealing would not help the cause any, as the enamel is fairly well annealed, due to the slow cooling of the metal. H. G. WOLFRAM: Steel and enamel having two different expansions could never be effectively annealed enough to remove the strain. R. R. DANIELSON AND H. F. STALEY: Annealing might be helpful, but a loss of gloss might be caused by subjecting the enamel parts to the high temperature for an unusual length of time. R. D. LANDRUM: Experiments were made to see whether slow cooling would add to the durability of the ware; the results did not show any measurable change. See *Jour. Amer. Ceram. Soc.*, **9**, 496 (1926). Very thin ware (glass) can with safety be cooled rapidly from the maximum temperature, but the safe cooling rate decreases very rapidly as the thickness increases.

Enamelist, **4** [1], 28 (1926).

MAKING VITREOUS ENAMELING SHEETS.—Description of the process used by the American Rolling Mill Co., at Middletown, Ohio.

Enamelist, **4** [1], 41 (1926).

CONTINUOUS PRODUCTION.—Layouts of two of the most modern enamel plants are shown and discussed.

Enamelist, **4** [2], 9 (1926).

INSTRUCTIONS FOR HAND-GRAINING.—Best results can be obtained from a paste made of one part of black overglaze and two parts of clove oil. A set of standard paint grainer's brushes are used for the graining. The graining paste, after being applied to the ware, does not have to be dry before being fired.

Enamelist, **4** [2], 13 (1926).

SHEET-STEEL ENAMELING.—Proper attention should be given to the firing of the ground coat. The firing time and temperature will depend upon the enamel and the gage of the material. Conditions should be such that it can be fired under 1600°F, as steel will warp above this temperature. The ware should be examined carefully before it is fired in order to detect faulty application of the enamel. Ware of different gages should be fired separately. Underfiring causes crazing, fishscale, spongy effect, etc.; overfiring will cause pimples or copper heads, fishscale, etc. Ground-coat enamel containing cobalt when properly fired will be blue-black with a semigloss luster, if underfired light blue, while overfired ware will be brownish black.

Enamelist, **4** [2], 17 (1926).

PIECE WORK DATA.—Data for Ohio job enameling shop. Average daily production on sandblasting is 5201 pounds, and on spraying 2937 pounds.

SPRAYING

Ground coat	25¢ per cwt.
White 1st, 2nd, and 3rd coat	25¢ per cwt.
(if not O.K'd by foreman, sprayer will not be paid)	
Colors, 1st coat	25¢ per cwt.
2nd coat	30¢ per cwt.
3rd coat (if O.K'd by foreman)	10¢ per cwt.
(if not O.K'd by foreman, sprayer will not be paid)	
Black, 1st coat	30¢ per cwt.
2nd coat (if O.K'd by foreman)	10¢ per cwt.
(if not O.K'd by foreman, sprayer will not be paid)	
Walnut } Same rate as for black.	
Mahogany }	

SANDBLASTING

Operator	20¢ per cwt.	Raw castings
Helper	13¢ per cwt.	Raw castings
Operator	49¢ per cwt.	Enameled castings
Helper	26¢ per cwt.	Enameled castings

Enamelist, **4** [4], 8 (1927).

PORCELAIN OR VITREOUS ENAMEL?—From an article in the *Good Housekeeping Magazine* concerning the confusion caused by the word enamel being used to refer to both vitreous enamel and paint enamel finishes.

Enamelist, **4** [4], 15 (1927).

FUEL CONSUMPTION VS. PRODUCTION.—Description of furnaces, driers, and boilers is given, as well as the method of firing both sheet iron and cast iron. The number of pounds of cast iron and sheet iron fired in one coat in one month follows:

Cast iron finished in all colors	160,000 lbs.
Sheet iron finished in all colors	16,000 lbs.
Cast iron, resandblasted (6%)	9,600 lbs.
Total finished work	185,600 lbs.

Firings:

All cast iron 2 coats	339,200 lbs.
Third coat 15% of 169,600	25,440 lbs.
All sheet iron 3 coats	48,000 lbs.
Total pounds fired	412,640 lbs.

Oil consumed

Total fuel oil used for all burners	17,606 gal.
Oil cost 5.13¢ at siding	
Actual oil bill for month	$903.19
Fuel cost per pound fired—1/8 cent.	

Enamelist, **4** [4], 17 (1927).

MORE ON AMERICAN RADIATOR.—Details on the system in the new American Radiator enameling plant.

Enamelist, **4** [4], 22 (1927).

GLOBE STOVE INSTALLS UP-TO-DATE ENAMELING PLANT.—Short description of the Globe Stove & Range Company, Kokomo, Ind.

Enamelist, **4** [5], 6 (1927).

INSTALLS REFRIGERATOR ENAMELING PLANT.—Short description with several illustrations of the Illinois Refrigerator Co., Morrison, Ill.

Enamelist, **4** [5], 12 (1927).

ABSTRACTS OF PAPERS PRESENTED AT THE CERAMIC MEETING.

Enamelist, **4** [5], 28 (1927).

PORCELAIN SIGN PRICES.—Standard prices for indestructible enameled steel signs (all signs to be made from same stencil):

Sq. in.	1	5	25	50	100	250
12	$2.40	$1.10	$0.62	$0.54	$0.45	$0.36
24	2.88	1.34	0.80	0.68	0.51	0.42
48	4.00	1.72	1.09	0.89	0.75	0.58
72	5.08	2.16	1.36	1.06	0.85	0.66
96	6.22	2.64	1.69	1.19	0.95	0.75
120	7.42	3.00	1.90	1.30	1.05	0.85
Sq. ft.						
1	8.20	3.56	1.95	1.40	1.15	
1½	9.60	4.18	2.40	1.75	1.55	
2	11.00	4.80	2.80	2.10		
2½	12.00	5.20	3.10	2.60		
3	13.00	5.60	3.50	2.90		
4	15.00	6.90	4.20	3.50		
5	17.00	8.00	4.80	4.00		
6	19.00	9.00	5.75	4.80		

Prices are for any two standard colors; white is a color; special shades extra. Add 50% for each extra color in quantities up to 12, and 20% in quantities of 25 or more. For drum signs, add 10%. For double-faced signs, add 100% in quantities up to 25 and 80% for over 25. The above prices are for plain lettering and simple design. Extra amount of wording or complicated design or cut-out shapes charges extra and subject to special quotation.

Enamelist, **4** [6], 7 (1927).

A CONE SCREEN TEST FOR MILLED ENAMELS.—The use of a cone screen as a method of control for grinding is described.

Enamelist, **4** [6], 15 (1927).

PIECE WORK PRICES.

SPRAYING SHEET IRON

First and second coat	21¢ per 100 sq. ft.
Third coat	18¢ per 100 sq. ft.
For both sides—add 50%	
Black edge	15¢ per 100 sq. ft.
Decal transfers	1¼¢ each

SPRAYING CAST IRON PER 100 LBS.

	White	Gray	Black
First coat	16¢	15¢	18¢
Second coat	18¢	18¢	18¢
Third coat	18¢	15¢	

FIRING CAST IRON

Per 100 lbs.	17½¢
Firemen	55%
Helper	45%

FIRING SHEET IRON

Ground coat	35¢ per 100 sq. ft.
White coat	28¢ per 100 sq. ft.
Fireman	55%
Helper	45%

The penalty for spoiled work is double deduction: Bonus for girls is $1.00 a week for full attendance.

Enamelist, **4** [6], 16 (1927).

LABORATORY TESTS.—A test for clay used by the American Radiator Co. is given as follows: In order to see how long clay will stand in suspension in water, one gram of clay was ground with water and diluted to 105 cc. in a graduated cylinder. The settling of clay was then watched and recorded at different intervals of time.

Enamelist, **4** [6], 20 (1927).

AVERAGE LABOR COSTS.—Figures are given showing the average labor cost for producing 100 sq. ft. of finished sheet-iron enameling to be $3.82 and the cost for 100 lbs. of finished cast-iron enameling to be $1.89.

Enamelist, **4** [7], 9 (1927).

MORE COST DOPE.—Comparative figures are given as follows:

	Sq. ft. sheet steel	Lbs. cast iron
1922	0.0488	0.0187
1923	0.043	0.015
1924	0.0449	0.013
1925	0.0495	0.0192
1926	0.039	0.0177
1927	0.0411	0.0246

OPERATION COST PER SQ. FT. SHEET STEEL

	Pickling	Dipping	Firing	Spraying
1922	0.0144	0.0094	0.0142	0.0094
1923	0.0133	0.0157	0.0188	0.019
1924	0.0126	0.0142	0.0201	0.0142
1925	0.0103	0.012	0.0163	0.012
1926	0.0134	0.0124	0.0189	0.0128
1927	0.0097	0.008	0.0159	0.0096

CAST IRON PER POUND

	Sandblasting	Spraying	Firing
1923	0.0421	0.037	0.0076
1924	0.0326	0.0178	0.0374
1925	0.0533	0.0118	0.0218
1926	0.0305	0.0117	0.0159
1927	0.0301	0.0096	0.017

Enamelist, **4** [8], 23 (1927).

GOOD SYSTEM FOR PRICING CAST-IRON LABOR.

SPRAYING PER 100 POUNDS

Ground coat

	Large	Both sides	Small
Sprayer	$0.10	$0.15	$0.20
Helper	0.06	0.09	0.12
Sprayer without helper	0.16	0.24	0.32

First color coat and black

Sprayer	0.11	0.16	0.22
Helper	0.07	0.10½	0.14
Sprayer without helper	0.18	0.27	0.36

Second color work

Sprayer	0.06	0.09	0.12
Helper	0.03	0.04½	0.06
Sprayer without helper	0.09	0.13½	0.18

Helper fills holes. Pieces of one pound or less are considered small work.

SANDBLASTING

De-enameling sandblasting pays the following rates:

With helper	Without helper
30¢ per cwt. 1 side enamel	45¢ per cwt. 1 side enamel
40¢ per cwt. 2 sides enamel	60¢ per cwt. 2 sides enamel

REGULAR SANDBLASTING

With helper	Without helper
20¢ per cwt. 1 side	30¢ per cwt. 1 side
30¢ per cwt. 2 sides	45¢ per cwt. 2 sides

Sandblasting where castings require only one coat of black enamel pays:

With helper	Without helper
12¢ per cwt. casting black enamel	15¢
12¢ per cwt. casting reclean	15¢

The rate for cast-iron firing is 50¢ an hour for 8 hours with bonus of 10¢ per 100 lbs. after 2000 pounds of castings have been fired.

Enamelist, **4** [9], 22 (1927).

ELECTRIC REFRIGERATION GROWTH.—The annual sales are given as follows:

1919	3,000	1923	16,000
1920	5,000	1924	17,500
1921	7,000	1925	75,000
1922	11,000	1926	200,000

Enamelist, **4** [9], 26 (1927).

HISTORY OF THE BECKWITH COMPANY.—Short history of the Beckwith Co., Dowagiac, Michigan.

Enamelist, **5** [2], 18 (1927).

A. B. C. PLANT.—The process of the Altorfer Bros. Co., Peoria, Ill., is described. This company has the distinction of being the first manufacturer of washing machines to install a porcelain enameling department.

Enamelist, **5** [3], 14 (1927).

OBSERVATIONS ON BRITISH ENAMELING CONDITIONS.—Short review of the condition of the industry in Great Britain.

Enamelist, **5** [3], 26 (1927).

BUREAU OF STANDARD TESTS WHITE GROUND COAT.—Abstract of test published in the November (1927) issue of *Technical News*.

Enequist, Erik

CHEMISTRY OF OPAQUE GLASS AND ENAMEL. *Chem. Eng.*, **10**, 54.—E. claims that the opal color is due to SiF_4. He recommends about 2% of lead in opal batches. "Opalin" consists of 25% Na_2SiF_6, the remainder being feldspar and fluorspar. Three formulas are given for using "rydolith" and "alabastolite" in opal glass. (*Chem. Abs.*, **3**, 2865 (1909).)

Engineer, **92**, 194, 238, 264, 323, and 347 (1901).

ENAMELING.—A detailed description of the manufacture of enameled ware is given, with diagrams of the apparatus employed. In particular, attention is drawn to the decadence of enameling in England. It is also shown how the industry has undergone an enormous development in Austria and Germany. The enameling industry includes: (1) hollowware enameling for domestic use; (2) hollowware enameling for chemical use; (3) enameling locomotive and other tubes; (4) enameling drain and water pipes; (5) signboard enameling. All enameled ware receives a fundamental or "gray" coating of a composition chiefly composed of glass. This is followed by a coating of "white" or glaze, any additional color required being laid on above the white. In sign board enameling, the iron plates, after leveling or setting, are dipped into a hydrochloric acid (1:1) bath, then heated to redness to loosen the scale, cleaned in dilute sulphuric acid, rinsed in cold water, thoroughly scoured with fine sand, rinsed in boiling water, and allowed to dry. With hollowware, the hydrochloric acid bath may be omitted. The enameling process should immediately follow the drying, The enamel mixings are applied to the metal either in the form of a powder or of a liquid paste, the latter method being the one more generally in use at the present time. When the enamel is applied as a powder, the metal is first rubbed with a cloth which has been dipped in a solution of gum, and the powder then carefully dusted through a sieve over the surface. When using the liquid paste, either the surface to be coated is dipped into the liquid or the latter is carefully poured over it, any surplus being drained off, and any parts which are not to be coated wiped clean with a cloth. The first or "gray" coating is dried at about 160°C, and then fused on in a suitable furnace (usually a muffle), at a cherry-red to white heat (about 1200°C). The object is then allowed to cool slowly and uniformly. The "white" coating which is next applied, should be made as liquid as possible, and should be fused on at a somewhat lower temperature (about 1050°C). The colored coating is applied in a similar manner to the white. In preparing the enamel mixings, the constituents are thoroughly ground and mixed, fused together, and reground. The fusing of the mixture is carried on in crucibles in suitable furnaces, and the melt is run into water, in order to render the material brittle and easy to grind. In grinding, it is essential that the construction of the mill be such as to prevent any iron-fitting from coming in contact with the material, as contamination with iron would cause discoloration of the enamel. The mixing of the powdered enamel constituents can be carried on in rotating barrels or churns. The "gray" or fundamental mixing should be kept in a condition only just sufficiently liquid to permit being poured out, a suitable quantity of water being added when the mixing is required for use. The "white" composition is mixed with water and kept in tubs until used; it should be carefully protected from dust. The plates or other articles must first be thoroughly cleaned. The "gray" coating must be "fused not only on but also into the metal" at a bright red, almost white, heat, and must fuse at a higher temperature than the "white" composition, so that it is not affected when the latter is applied. The compositions should have approximately the same capacities of expansion and contraction as the metals to which they are applied. After the application of the enamel coatings, slow and uniform cooling of the articles is essential. It is important both for the sake of economy and for obtaining good results, that experimental tests be made with each separate batch of enamel mixings. The following are examples of the compositions employed: For "gray" or fundamental coatings:

(1) Frit	Per cent	(2) Frit	Per cent
Almost any kind of glass	49	Glass (any kind)	61
Oxide of lead	47	Red lead	22
Fused borax	4	Borax	16
		Niter	1

(3) Frit

	Per cent
Quartz	67.5
Borax	29.5
"Enameling soda"	3.0

Especially adapted for iron pipes

(4) Frit

	Per cent
Silica powder	60
Borax	33
White lead	7

Fused and then ground with $^3/_{10}$ weight of silica frit
Clay, $^3/_{10}$ weight of silica frit
Magnesia, $^1/_6$ weight of white lead

(5) Frit

	Per cent
Silica	65
Borax	14
Oxide of lead	4
Clay	15
Magnesia	2

This is a fair average of several mixings, and can be varied slightly to suit different conditions of work

For "white" or glaze:

(1) Frit	Per cent
Feldspar	33
Borax	22.5
Quartz	16.5
Oxide of tin	15.0
Soda	8.0
Fluorspar	3.75
Saltpeter	2.25

(2) Frit	Per cent
Cullet	20
Powdered flint	15
Lead	52
Soda	4.5
Arsenic	4.5
Niter	4.0

(3) Frit	Per cent
Silica powder	30.0
Oxide of tin	18.0
Borax	17.0
Soda	8.5
Niter	7.5
White lead	5.5
Ammonium carbonate	5.5
Magnesia	4.0
Silica powder	4.0

(4) Frit	Per cent
Silica powder	26
Oxide of tin	21
Borax	20
Soda	10.25
Niter	7
Ammonium carbonate	5
Magnesia	3.25

No. 4 Frit should be ground up with the following:

	Per cent
Silica powder	4.25
Oxide of tin	2.25
Soda	0.50
Magnesia	0.50

(5) Frit	Per cent
Feldspar	41
Borax	35
Oxide of tin	17
Niter	7

(6) Frit	Per cent
Borax	30.0
Feldspar	22.0
Silica powder	17.5
Oxide of tin	15.0
Soda	13.5
Niter	2.0

(7) Frit	Per cent
Borax	28.0
Oxide of tin	19.5
Cullet	18.0
Silica powder	17.5
Niter	9.5
Magnesia	5.0
Clay	2.5

To Frit 7 must be added, while being ground, the following percentages of the weight of the frit:

	Per cent
Silica powder	18
Borax	9
Magnesia	5.25
Boric acid	1.5

(8)	Per cent
Borax	26.75
Cullet	19
Silica powder	18.5
Oxide of tin	19
Niter	9.25
Magnesia	4.50
Soda	3

To this should be added, while being ground, the following percentages of the weight of the frit:

	Per cent
Silica powder	1.75
Magnesia	1.75
Soda	1

No. 1 is for pipes, Nos. 2 and 3 for sign tables, and Nos. 4 to 8 for culinary utensils. For coloring enameling frits the following are chiefly used: *blue*, silicate of cobalt or smalt; *violet*, peroxide of manganese; *green*, oxide of copper, with, if necessary, an addition of oxide of iron; *yellow*, Naples yellow; *orange*, red oxide of iron and an antimony preparation mixed so as to give the desired tint; *red*, sulphate of iron and alumina; *brown*, mixture of black and purple, oxide of iron mixed with a certain proportion of clays; *black*, oxides of iron, cobalt, and manganese. (*Chem. and Ind.*, **20,** 1113 (1901).)

Engineering, **103,** 410 (1917).

CONTINUOUS ENAMELING AND STOVING MACHINE FOR SMALL PARTS.—Description of mechanical details. (*Chem. Abs.*, **11,** 2146 (1917).)

Engineering, **122,** 19 (1926).

SOUNDNESS IN STEEL TUBES.—Corrosion and pitting are associated with segregates. Segregates include sulphides, but seldom consist mainly of them. The low sulphur found in Swedish steel does not make it reliable against segregation and the troubles that arise from it. Segregation occurs in the ingot, and no matter what physical or mechanical treatment it or its products may receive, they carry the segregates with them throughout their life until they are remelted. Accordingly failure may be avoided most easily if an examination by sulphur printing is made on the original ingot. (*Ceram. Abs.*, **6,** 9 (1927).)

Engineering and Mining Journal, **112,** 936 (1921).

NONMETALLIC AND ENAMELED WARE "CONSULTATION."—Mentions minerals used in enameling iron, and gives ingredients for one ground coat and one finishing coat. (*Ceram. Abs.*, **1,** 134 (1922).)

Erichsen, E. J.

PROCESS FOR THE ENAMELING AND CEMENTING OF METALS. German Pat. 16,364, June, 1881.—The surface to be enameled is cleaned, covered with silicate of soda, then with a mixture of silicate of soda and asbestos, to which lime or gypsum can be added, and, finally, strongly heated. In order to cover a boiler with this mixture, it is surrounded with a wooden jacket, and the space between, which is about 5 cm. wide, is tightly packed with asbestos and silicate of soda. The inside of the boiler after cleaning with dilute sulphuric acid should also be covered with this mixture. The above mixture can also be used as a cement. (*Chem. and Ind.*, **1,** 154 (1882).)

Erwin, M. E.

ENAMELED VESSEL. U. S. Pat. 677,309, June 25, 1901.—As a new article of manufacture, a vessel comprising a rim having a flange on each edge, the ends of the rim being suitably secured together, sides having flanges adapted to be interlocked with those of the rim, a neck or mouthpiece fitting an opening in the rim and held in place by having its inner end out-turned or flanged, to bear against the inner surface of the rim, and an enamel coating covering the interior and exterior of the vessel and fused between the flanges, thus presenting a seamless and practically acid- and fireproof structure.

Esch, W., and Schultz, F.

IMPORTANCE OF FLUORINE COMPOUNDS IN ENAMELS. *Chem. Ztg.*, **48**, 901 (1924).—The history of the use of Na_2SiF_6 is reviewed. (*Ceram. Abs.*, **4**, 156 (1925); *Chem. Abs.*, **19**, 1336 (1925).)

Essayan, H. G.

ENAMEL FOR METALS. U. S. Pat. 1,091,492, Mar. 31, 1914.—Heating a mixture of 2% silver, 8% copper, and 8% lead, melted together with 82% sulphur and powdering the product. (*Chem. Abs.*, **8**, 1861 (1914).)

Estate Stove Co.

NEW TYPE FORK RAISES PRODUCTION 200%. See *Ceram. Ind.* (this *Bibliography*, p. 56).

Estep, H. C.

FALKIRK USES NEW METHODS. *Foundry*, **52** [9], 331 (1924).—Contains a description, illustrated with photographs, of the application of the Beardsley and Piper sand-slinger to the manufacture of bathtubs, in the plant of M. Cockburn and Co., Falkirk, Scotland. (*Ceram. Abs.*, **3**, 240 (1924).)

Euler, B. T.

GROUND COAT DIPPING. *Enamelist*, **2** [10], 19 (1925).—A test piece is used to see that the weight of enamel per square foot remains fairly constant. If the enamel is too thin, a small amount of thick enamel is added rather than borax. The borax formerly added as a coagulant is added in the raw state to the mill. The tub used for dipping is 12 ft. 8 in. long, 26 in. wide, and 15 in. deep. A splasher 20 in. high was added to the back and ends. S-shaped hooks are suspended from the splash board for the pieces to hang upon while draining.

Evans, U. R.

POROSITY AND CORROSION. *Chem. and Ind.*, **45B**, 37 (1926).—During recent years, metallurgists have come to the view that even apparently sound metals, cast and rolled sheet, are threaded by cavities. Tammann endeavored to measure the volume of these cavities by filling them with dye solution. E. classifies corrosion, which covers ordinary pitting and also the internal attack which causes loss of strength within ware without producing conspicuous change on the surface, into four types: (1) regional, (2) point, (3) line, (4) edge-point. All four types may sometimes be seen on one specimen. Regional corrosion begins and continues over an area, advancing often along horizontal lines; the other three begin differently, according to their nomenclature, but develop into similar-looking lines or streamers. It is believed that the cause of corrosion is the cavities and capillaries in the metal. (*Ceram. Abs.*, **5**, 143 (1926).)

Eyer, P.

ANTIMONATES, ENAMEL, AND GLAZES. British Pat. 11,083, July 30, 1915.—Antimonates of alkaline earths, Al, Mg, Zn, Sn, Zr, Be, etc., for use as clouding agents for enamels and glass, are produced by heating a mixture of Sb_2O_3 and a metal oxide with NH_4NO_3 until the latter is all driven off. The metal oxide may be used in excess, or two or more metal oxides may be used; instead of oxides, compounds yielding oxides may be employed, such as carbonates. Examples describe the production of magnesium and zinc antimonate, and of a mixed antimonate from tin oxide and clay. The products may be mixed with other clouding agents. (*Chem. Abs.*, **11**, 198 (1917); *Chem. and Ind.*, **35**, 839 (1916).)

Eyer, P.

ENAMELING FURNACE. German Pat. 257,526, Mar. 31, 1911.—Consists of a closed muffle with rotating grate. (*Chem. Abs.*, **7**, 2460 (1913).)

Eyer, P.

ENAMEL GLAZING. U. S. Pat. 1,118,898, Nov. 24, 1914.—Formed of boracite 34.3, sodium silico-fluoride 8.8, quartz 10, feldspar 33, soda 12, potassium nitrate 7.5, and cobalt oxide 0.3 part. (*Chem. Abs.*, **9**, 136 (1915); *Chem. and Ind.*, **34**, 81 (1915).)

Eyer, P.

GROUND ENAMEL. U. S. Pat. 1,249,937, Dec. 11, 1917.—Ore containing cobaltic oxide, freed from sulphur and arsenic, is used to color the enamel, and improve its adhesion to the metal on which it is applied. (See English Pat. 107,392 of 1916.) (*Chem. Abs.*, **12**, 414 (1918); *Chem. and Ind.*, **36**, 963 (1917); *ibid.*, **37A**, 89 (1918).)

Eyer, P.

ENAMEL FOR IRON. U. S. Pat. 1,256,455, Feb. 12, 1918.—White enamel for iron consisting of ruby glass 60, clay 16, cryolite 12, and sodium carbonate 7 parts. A substitute for borax, quartz, and feldspar in enamel mixtures may be prepared by melting together glass 80, sodium carbonate 40, borax 30, and clay 40 parts. Two parts of this product may replace borax 1, quartz 1, and feldspar 0.5 part as a fluxing material in ordinary enamels. Other formulas are given in which glass of low melting point replaces borax in part as a flux in enamels of otherwise ordinary composition. U. S. Pat. 1,256,456 specifies an enamel formed of ruby glass 3, feldspar 25, natural calcium borate 30, sodium fluosilicate 4.8, soda 8, potassium nitrate 3, nickel oxide 0.3, and cobalt oxide 0.05 parts or pressed glass 30, feldspar 25, clay 12, calcium borate 15, sodium fluosilicate 15, soda 4, and potassium nitrate 1 part. (*Chem. Abs.*, **12**, 986 (1918); *Chem. and Ind.*, **37A**, 209 (1918).)

Eyer, P.

CLOUDING COMPOSITION FOR ENAMELS AND PROCESS OF MAKING IT. U. S. Pat. 1,314,861, Sept. 2, 1919.—ZrO_2 and other zirconium compounds have been substituted for SnO_2 as opacifiers, but they produce spotted and dull or tarnished enamels. Zirconium borate is comparatively free from these defects, but its covering capacity is insignificant. E. has found that zirconium borate strongly supersaturated with zirconium oxide, such for instance as a product of the composition $ZrO_2 \cdot 2B_2O_3 + 4ZrO_2$ has a greater covering power than ordinary zirconium borate and at the same time does not cause spotting or dullness. The covering power of the compound is also increased by melting cryolite with it. Cheap raw zirconia can be used provided an oxidizing agent is employed. Example: raw ZrO_2 70 parts, B_2O_3 30 parts, Na_3AlF_6 20 parts, NaNO 50 parts, are thoroughly mixed, fused, and ground very fine. (*Jour. Amer. Ceram. Soc.* (Abs.) **2**, 927 (1919); *Chem. Abs.*, **13**, 2748 (1919); *Chem. and Ind.*, **38A**, 820 (1919).)

Eyer, P.

COMPOSITION OF IRON ENAMELS. *Chem. Ztg.*, **32**, 516 (1908).—There are two kinds of enamels to be distinguished, one applied to sheet iron, the other to cast iron. In covering sheet iron with an enamel, a ground coating must be put on first which is to prevent the reduction of the metallic oxides in the enamel by the carbon of the iron. Such a ground consists of a frit made by fusing 17 parts SiO_2, 30 feldspar, 46 borax, 2 soda, 3 Na_2SiF_6, 2 KNO_3, 0.18 CoO, 0.42 NiO, and 0.03 CuO. To the frit 7% of clay must be added on grinding. In the enamel proper opacity is produced by a mixture of

SnO_2 and cryolite. A modern composition for an enamel is as follows: 10.5 parts of SiO_2, 37.5 feldspar, 18 borax, 12 cryolite, 0.7 KNO_3. In grinding, 8% SnO_2 and 7% clay are added to this frit. Recently, owing to the high price of natural cryolite, an artificial mixture corresponding to cryolite has been used advantageously. For a cast-iron ground cover the following mixture is used: 13.04 parts SiO_2, 26.08 feldspar, 14.40 boric acid, 3 borax, 4.7 Na_2CO_3, 4.34 KNO_3, 17.40 PbO, 2 $CaCO_3$, 2 MgO, 11.04 cryolite, 0.2 fluorspar, 7% clay, and 7% SnO_2 are added to the frit on grinding. The so-called stove-glaze is a composition containing lead which is melted on to cast iron direct or on to enameled iron. It is fused at a very low temperature. It does not represent an advance over the usual composition. A green stove glaze imitating the majolica glazes applied on clay has the following composition: 8 parts feldspar, 20 borax, 25 PbO. In grinding, 3% Cr_2O_3 and 3% $Fe(OH)_3$ are added to the frit. (*Chem. Abs.*, **2**, 2132 (1908); *Chem. and Ind.*, **27**, 628 (1908).)

Eyer, P.

HOW MUCH OF THE HEAT APPLIED TO ENAMEL FIRING AND MELTING OVENS IS USEFUL. *Glashütte*, **41**, 931 (1911).—E. describes an oven which he has designed and for which he claims superior heat economy. (*Chem. Abs.*, **6**, 415 (1912).)

Eyer, P.

SCIENTIFIC ENAMELING. *Glashütte*, **42**, 8 (1912).—An exhaustive treatise. (*Chem. Abs.*, **7**, 3004 (1913).)

Eyer, P.

ASSUMED REDUCTION OF ANTIMONIC TO ANTIMONOUS COMPOUNDS IN ENAMELS. *Glashütte*, **43**, 266–327 (1913).—Such a reduction does not take place and is furthermore impossible in a muffle furnace under the conditions. (*Chem. Abs.*, **7**, 3004 (1913).)

Eyer, P.

QUARTZ AND CLAY IN ENAMELING. *Glashütte*, **43**, 662. (*Chem. Abs.*, **7**, 3647 (1913).)

Eyer, P.

USE OF SODIUM SILICO-FLUORIDE IN ENAMEL GLAZES AND IN THE GLASS INDUSTRY. *Glashütte*, **44**, 205 (1914).—Polemic against Loeser. See Loeser (this Bibliography, p. 201). (*Chem. Abs.*, **8**, 2468 (1914).)

Eyer, P.

WHITE CLOUDING MATERIALS FOR ENAMELS. *Glashütte*, **44**, 247, 268 (1914). (*Chem. Abs.*, **8**, 2469 (1914).)

Eyer, P.

MELTING OF ENAMELS. *Ill. Ztg. Blechind*, p. 640 (1912); *Chem. Ztg. Rep.*, **36**, 654.—In place of the prevalent inadequate hand-mixing of raw materials in large enameling works, E. recommends use of a combination of mechanical mixer and sifter. It is important that the raw materials be introduced into a very hot oven. (Editor, *Chem. Ztg.*, disagrees with this. He states that in such cases premature decomposition occurs with incomplete interaction of acids and bases.) For ground enamels, the bath should be kept at a higher temperature than for surface enamels, and the flux for the former should be such that tests taken from time to time show entire absence of granules. If the bath for white enameling be heated too strongly, the substances causing opacity are dissolved rather than suspended, the enamel becomes yellow, and its covering power is diminished. In direct firing, bituminous, tar-producing fuels must be avoided. These injure the batch because of the formation of noncombusting graphite. Long flame coals are best in direct firing, while briquets are unsuitable. Lead and specially colored

enamels are best made in pots in which they can be completely protected from direct contact with the flame. (*Chem. Abs.*, **7**, 2459 (1913).)

Eyer, P.

REFERENCE BOOKS ON ENAMELS. See *Jour. Amer. Ceram. Soc.* (this *Bibliography*, p. 166).

Eyer, P.

NATURAL HISTORY OF ENAMEL DEFECTS. *Keram. Rundschau*, **20**, 233, 243, and 252 (1912).—Blisters are due to gas enclosed in the sheet steel, to excessive carbon in the metal reducing the tin oxide in the enamel, and to the carbon monoxide formed. The heating of the metal must be done at the proper temperature, neither too high nor too low. The hollowware must be so placed that no warping takes place. The acid treatment should be done with a solution containing 7 to 8% HCl in which the ware should remain 45 to 60 minutes. If H_2SO_4 is used the solution should contain 4% acid and should be kept at 40 to 50°. The time for this batch is 15 to 20 minutes. For cast iron, the solution may be cold and should not contain more than 1.5% H_2SO_4. In this case, the time is 90 minutes. The washing in water should be continued for two hours. Welded parts should be cleaned with sandblast to remove carbon or enclosed dirt. The enamel should not be ground too fine, since this causes cracking. MgO and Na_2CO_3 tend to prevent this. Cracking is due to the greater expansion of the ground as compared with the covering enamel. A hard ground fits a soft top coat. A ground containing 52% SiO_2 fits a cover enamel containing 50%. For a cast ground the following was suitable: 38 feldspar, 8 borax, 2.5 fluorspar, 2 bone ash. In the mill 8% clay and 2% soda are added. Any ferric oxide used should be free from S. (*Chem. Abs.*, **6**, 3505 (1912).)

Eyer, P.

DESIGN AND EQUIPMENT OF AN ENAMELING PLANT. *Keram. Rundschau*, **20**, 433, 447, 538 (1912); *ibid.*, **21**, 24, 47 (1913). (*Chem. Abs.*, **7**, 2102 (1913).)

Eyer, P.

TIN OXIDE SUBSTITUTE. *Stahl u. Eisen*, **28**, 1097 (1908).—Tests of cryolite, which may replace about 12% of the tin. Antimony and arsenic oxides, bone ash, titanic acid, and zirconium oxide have the following objections: antimony and arsenic: poisonous (cooking ware); bone ash: decomposed by stronger acids in the enamel; titanic acid: makes enamel too brittle; zirconium oxide: too expensive. (*Chem. Abs.*, **2**, 3135 (1908).)

Eyer, P.

INTRODUCTION TO THE FLUORINE QUESTION IN ENAMEL FRITS. *Keram. Rundschau*, **34**, 294 (1926).—Various theories on the opacifying effect of fluorine in enamel frits are discussed. References are made to recent literature. (*Ceram. Abs.*, **6**, 327 (1927).)

Fairchild, D. H.

EXPERIMENTAL STUDY OF BALL-MILL GRINDING. *Eng. and Min. Jour. Press.*, **116**, 845 (1924).—Fairchild studied the action in ball mills with heavy glass end plates by observation and by motion pictures. The factors in ball-mill action are impact crushing, attrition, and dead weight. Impact crushing is by far the most important. In the usual ball mill of circular section this action takes place largely only in the upper surface zones of the charge, with large zones at the center and next the walls comparatively inactive. The circular section gives little wear on linings and best distribution of loading, but varied forms may be developed that will cause "a more rapid change of mill

content" and "more effective agitation within the ball mass." (*Ceram. Abs.*, **3,** 51 (1924).)

Faisst

ANALYSIS OF ENAMELS FOR DIALS. *Bair. K. u. G. Bl.* (1853); *Dingler's polytech. J.*, **127,** 465. (*Rept. der Tech. Lit.*, p. 272 (1823–1853).)

Faisst

ANALYSIS OF ENAMEL OF CAST IRON. *Dingler's polytech. J.*, **136,** 74; *Ctrlbl.*, p. 700 (1855). (*Rept. der Tech. Lit.*, p. 306 (1854–1868).)

Farben Ztg., **18,** 142 (1913).

OLD AND NEW COLORS WITH COBALT AS THEIR BASE.—A historical sketch reviewing the use of cobalt in enamels and glass manufactured in ancient and modern times. (*Chem. Abs.*, **7,** 874 (1913).)

Farrar, D. F.

GRINDING FELDSPAR IN TENNESSEE. *Eng. Min. Jour.-Press.*, **122,** 692 (1926).—One principal source of supply of potash feldspar is in Tenn. along the western border of N. C. The mineral occurs in great quantities in pegmatite dike. It is mostly hand-picked when loaded in railroad cars for shipment about 50 miles to Erwin, Tenn. At Erwin there are 3 grinding plants and at Bristol, Tenn., there is one. These 4 grinding plants produce $^1/_3$ of the total production of the U. S. A typical analysis of a sample from these plants is: silica, 65.10%; alumina, 20.38%; potash, 11.16%; soda, 1.10%; lime, 1.96%. This is very close to the theoretical composition of pure orthoclase and shows that the hand-picking method of the lump rock, to free from quartz and other impurities, is well done. The same general method of procedure in grinding is used at all 4 plants; *e.g.*, jaw-crushers for preliminary crushing; then Hardinge mills which were in some cases followed by tube mills. All grinding is conducted dry. Ground feldspar is supplied to the trade in 3 grades of fineness; 80- to 100-mesh, 140-mesh, and 200-mesh. The glass manufacturers use the coarser size; 140-mesh is used in enamels and the pottery trade requires the 200-mesh size. The average capacity output of ground feldspar per plant is from 1500 to 3600 T. per month. (*Ceram. Abs.*, **6,** 34 (1927).)

Farrow, F. D., and Lowe, G. M.

FLOW OF STARCH PASTE THROUGH CAPILLARY TUBES. *J. Textile Inst.*, 14 P. T. 414 (1923).—(1) The viscosities of solutions of potato starch (farina) and of maize starch have been studied at 90° up to concentrations of 5%. (2) With an instrument of the Ostwald type, the apparent viscosity of farina paste gradually rises with increasing amounts of starch until a concentration of about 0.7% is reached. At higher concentrations than this, the increase of apparent viscosity is much more rapid. (3) For maize pastes, measurements in an Ostwald viscometer give results similar to those found with farina, but the rapid increase with concentration of the apparent viscosity does not occur till the concentration is greater than 1.5%. (4) The apparent viscosity of farina pastes, except the most dilute, decreases rapidly with time when they are stored at 90°. This change occurs only to a slight extent with maize pastes. (5) Maize pastes have been studied in an instrument in which variable pressure has been used to alter the rate of flow. These experiments have shown that the apparent viscosity is less as the driving pressure is increased, *i.e.*, that each unit of pressure is more effective in producing flow at high than at low pressures. (6) This behavior can be expressed by the relation $V/t = KP_N$, where $_N$ is a number characteristic of the paste and independent of the instrument in which the measurement is made. The value of $_N$ is unity for water and for purely

viscous liquids. It is greater than one for starch pastes, increasing with increasing concentration. In the formula in this and in the following paragraphs, p = pressure in cm. of water, P = pressure in absolute units = $p \times 981$, V = volume of fluid observed to pass in time, t, K = constant for the instrument determined by means of a standard liquid, $_N$ = a number characteristic of the paste, r and l radius and length of the tube, respectively. (7) It is suggested that a property (η), the "coefficient of flow" can be defined for starch pastes, which with the value of $_N$ fully describes the way in which they will flow through capillary tubes. (8) The relation between these quantities and the dimensions of a capillary tube through which the flow takes place is $(\eta) = P_N \pi r^4 t/8lV$, where all of the symbols except (η) and $_N$ refer to quantities which can be directly measured. The exponent $_N$ can be determined by plotting the logarithm of the rate of flow against the logarithm of the pressure, and measuring the angle between the graph and the axes of log P. The value of (η) can then be obtained by calculation. (9) Observations on a sample of inferior sizing sago and on "aged" farina pastes, suggest that $_N$ has an importance equal to that of (η) as a test for those properties of starch which are of value for sizing. (*Chem. Abs.*, **18**, 606 (1924).)

***Federal Electric Co.**

PRODUCTION OF ENAMEL SIGNS. See *Ceram. Ind.* (this *Bibliography*, p. 50).

Feldman, A.

IMPROVEMENTS IN PRODUCTION OF FIREPROOF MATERIALS AND ARTICLES OF ENAMEL. British Pat. 8064, June 17, 1886.—Fireproof and enameled articles are produced from a mixture of one or more of the fluorides of sodium, calcium, magnesium, strontium, barium, and aluminum with one or more of the following basic oxides: lime, magnesia, baryta, strontia, alumina, and oxide of zinc. The substances to be employed are powdered and mixed with water to form a dough, which is dried and fired at such a temperature that its ingredients will sinter together. (*Chem. and Ind.*, **6**, 547 (1887).)

***Fellows, Roger**

ENAMEL SYMPOSIUM. See Jaeger, F. G. (this *Bibliography*, p. 161).

***Ferguson, J. E.**

METHOD AND MACHINE FOR ENAMELING. See Whitmore, J. B. (this *Bibliography*, p. 334).

Fessler, A. H., and Kraner, Hobart M.

HYDROGEN-ION CONCENTRATION AND ELECTRICAL CONDUCTIVITY OF CLAY SLIPS. *Jour. Amer. Ceram. Soc.*, **10**, 501 (1927).—*I. Plant Study:* The apparatus and method of determinining the H-ion concentration and electrical conductivity of clay slips are described. Measurements were obtained on daily samples of tap water, casting and plastic slips, car shipments of clays, and individual blungers of slips in an endeavor to find whether any variations that might occur in the plant processes could be traced to variations in the slips indicated by these measurements. In a following paper values will be given showing the effect of temperature, time and vigor of stirring, specific gravity, and concentration of various salts, such as NaCl, Na_2SiO_3, $MgSO_4$, and $AlCl_3$, on the H-ion concentration, viscosity, and electrical conductivity of slips. (*Ceram. Abs.*, **6**, 350 (1927); *Chem. Abs.*, **21**, 3435 (1927).) *Jour. Amer. Ceram. Soc.*, **10**, 592 (1927).—*II. Laboratory Study:* This paper supplements a preceding paper on this subject. F. and K. have tried to determine in the laboratory the extent of variations on hydrogen-ion concentration, electrical conductivity, and viscosity caused by those variable conditions which might exist in factory operation such as temperature, vigor and time of stirring, salts, etc.

It appears that the viscosity of the slip remains to be the most indicative of its workability whereas its electrical conductivity shows some promise of being used as an additional method of control. Little promise was found for H-ion concentration determinations. *E.g.*, it should be remembered that the term p_H represents the logarithm of the reciprocal of the H-ion concentration, or $p_H = \log \left|\frac{1}{CH}\right|$. This is a logarithmic value. Therefore, a solution having a p_H value of 6.0 contains 10 times as many H-ions as one having a p_H value of 7.0. Also if the p_H increases in value the H-ion concentration decreases. (*Ceram. Abs.*, **6,** 401 (1927).)

Fettke, C. R.

GLASS SANDS. *Trans. Amer. Ceram. Soc.*, **19,** 160 (1917).—A general description is given of quarrying and washing methods. A table of sieve tests is given showing data on sands from Mapleton, Kennerdell, and Derry, Pa., and Ottawa and Rockwood, Ill. (*Chem. Abs.*, **12,** 521 (1918).)

***Ficheroulle, H. E.**

LUMINOUS ENAMELS. See Joose, P. F. (this *Bibliography*, p. 166).

***Fisher, Geo. P.**

LEADLESS ENAMELS. See Staley, H. F. (this *Bibliography*, p. 301).

Fix and Schmidt

TRANSPARENT AND OPAQUE ENAMELS ON WROUGHT IRON (SHEET IRON) BY MEANS OF LAYERS OF FINE GOLD OR SILVER FOIL. German Pat. 319,207, Mar. 12, 1919.—Sheet iron is first given a preliminary coat of enamel, which is fired on. An intermediate coating of powdered silver and an easily flowing flux mixed with a volatile oil is then applied, and, after drying, fired on, and polished. This serves as a carrier for the final layer of ordinary enamel on which the gold or silver foil is laid. The process is applicable to articles of jewelry and to the panelling of furniture. (*Chem. and Ind.*, **39A,** 491 (1920).)

Flach and Keil

ENAMEL ON CAST-IRON APPARATUS. *Dingler's polytech. J.*, **78,** 40; *Jahrb. d. p. J. B.*, **20,** 312; *Bair. K. u. G. Bl.*, p. 524 (1840). (*Rep. der Tech. Lit.*, p. 272 (1823–1853).)

Fleck, H.

APPLICATION OF DOMESTIC UTENSILS CONTAINING LEAD. *Chem. Centr. Bl.*, p. 676 (1884); *Rep. Anal. Chem.*, **15,** 234.—From a series of experiments made with enameled pots, F. concludes that their behavior to boiling vinegar varies considerably. He found that under certain conditions, enamels containing lead were not affected by vinegar. An enamel from which 0.041 gram lead per liter capacity had been dissolved, was prepared by the same manufacturer from the same raw materials, the only difference being that it was fired more strongly. This enamel was found to resist entirely the action of boiling vinegar. (*Chem. and Ind.*, **3,** 578 (1884); *ibid.*, **4,** 545 (1885).)

Fletcher, D.

ENAMELING MUFFLES. British Pat. 25,692, Nov. 8, 1909.—Muffles used for heating metal goods during the enameling process are constructed of the usual tunnel shape arched over at the top, and provided with an outer casing of brick, the smoke from the fires rising over vertical divisions fixed in the side space between the two chambers, traveling across the top of the outer one and down the side space through openings in the

floor to two outer flues arranged below the inner chamber, thence into two interior flues below the chambers where the unconsumed gases are led to a central down flue leading to the stack. The apparatus is provided with a series of air inlets controlled by plugs or dampers, and it is stated that the muffle is maintained at a uniform heat and the duration of the firebrick lining of the muffle is prolonged. (*Chem. and Ind.*, **29**, 1383 (1910).)

***Floyd-Wells Stove Co.**

NEW TYPE DRIER-RECUPERATOR FURNACE. See *Ceram. Ind.* (this *Bibliography* p. 57).

Forbes, Arthur W.

ENAMELING APPARATUS. U. S. Pat. 1,197,618, Sept. 12, 1916.—A device including a rigid frame having vertically disposed side bars adjacent to either end, and corrugated sheet-metal walls located inside the side bars, and having a row of loops struck out and threaded upon the side bars to hold the walls in engagement with the bars.

Forsbach, O.

MUFFLE FURNACES FOR ENAMELING. British Pat. 10,852, May 9, 1906; French Pat. 366,021, May 9, 1906.—In the furnace described, the reheated air for combustion passes, prior to its mixture with the gases for heating, through channels arranged at the side of the flues which pass round or envelop the muffle, and is led from these channels into the furnace, by a channel arranged under the furnace, so that it enters this at a temperature about equal to that of the furnace. The details of the construction of a muffle furnace working on this principle are described. (*Chem. and Ind.*, **25**, 985 (1906).)

Foundry, **52**, 982 (1924).

USE SODIUM FLUX FOR IRON.—The addition of 7 lbs. of soda ash to 1500 lbs. of molten iron in the ladle, reduced the sulphur 0.06%. (*Ceram. Abs.*, **4**, 99 (1925).)

France, Wesley G.

ULTRAMICROSCOPIC MOTION PICTURE STUDY OF RELATION OF COLLOIDAL CONTENT AND PLASTICITY IN CLAYS. *Jour. Amer. Ceram. Soc.*, **9**, 67 (1926).—Many attempts have been made to account for the plasticity of clay on the basis of colloidal content. If these are warranted then one should find characteristic differences in the colloidal fractions of clay suspensions when examined ultramicroscopically. Furthermore these differences should serve as an indication of the plasticity. Ultramicroscopic motion pictures were taken of the colloidal fractions of the aqueous suspensions of four clays having different plasticities. Marked differences were found in each instance, which indicated the relative order of the decreasing plasticity of the clays examined to be: English china clay; S. C. kaolin; N. C. kaolin; and fire clay semiflint. These results tend to support the idea that a definite relation exists between the colloidal content of a clay and its plasticity. Suggestions with reference to the extension of this work are made.

Franchet, Louis

ENAMELS AND CERAMIC COLORS OF THE MIDDLE AGES AND THE RENAISSANCE. *La Céramique*, **10**, 142 (1907).—Various compositions are given. Silver was used as the sulphide to obtain metallic luster. Bismuth was used by Xanto, who supposed it to be silver. A patent was given to Giacomo Lanfranco in 1569 for the application of metallic gold to faience. (Abstract more complete in *Chem. Abs.*, **2**, 2609 (1908).)

Franchet, L.

PREPARATION OF GRECIAN BLACK ENAMEL WITH NATURAL FERROSO FERRIC OXIDE. *Compt. rend.*, **152**, 1097 (1911); *Céramique*, **14**, 150 (1911).—Brongniart (1844) following Salvetat called attention to the presence of some MnO in the black enamel of the Graeco-Italian pottery but the presence of manganese is accidental and not necessary to the color which is produced by Fe_3O_4. Verneuil suggested that the iron was introduced as a metallic powder, his hypothesis being that the Greeks obtained this by reducing the oxide with carbon. The black enamel consists of a frit and a coloring agent; the opacity being due to an undissolved excess of the latter. The initial frit (18th Dynasty in Egypt) consisted originally of silica and salts of potassium and sodium. This frit with the addition of 50% hammer scale was used in making black glass. Hammer scale could not have been used for this enamel which vitrifies above its melting point and was fired oxidizing. The following formula gave, in the oxidizing fire, a very good imitation of the enamel in question and vitrified at about 850°. Frit: quartz sand 55, Na_2CO_3 45; enamel: frit 50, magnetite 50. Substituting chalk for 10 parts of SiO_2 gave equally good results but the use of pure Fe_3O_4 was followed by oxidation. Glue of some sort was probably used to thicken the enamel and its carbon on firing would help prevent oxidation. Egypt, not Greece, should have the credit for originating this enamel. (*Chem. Abs.*, **5**, 3504 (1911); *Chem. and Ind.*, **30**, 622 (1911).)

Francis, James Henry Edward

VITREOUS ENAMELED TILE, BRICK, ETC. U. S. Pat. 1,535,301, April 28, 1925.—A vitreous enameled tile, brick, etc., formed from a metal plate having inwardly curved edges, characterized in that the edges throughout their length are each inwardly turned through an angle greater than 90° without joint, as set forth. (*Ceram. Abs.*, **4**, 184 (1925).)

Franck, A. H.

DEVICE FOR CHARGING AND DISCHARGING ENAMELING OVENS. U. S. Pat. 463,503, Nov. 17, 1891.—The combination, with an enameling furnace, of a permanent grate in the same, an independent removable fork having tines fitting between the grate bars, and a conveyer located outside of the furnace for introducing the fork into the furnace and removing it from the same.

Frazier, C. E.

MUFFLE OVEN FOR DECORATING OR ANNEALING GLASS OR ENAMELWARE. U. S. Pat. 1,389,583, Sept. 6, 1921.—A furnace comprising a primary combustion chamber and secondary chambers located at opposite ends of the primary chamber, means separating the chambers, a muffle extending through the furnace beneath the chambers and comprising a floor, side walls, and a roof, vertical flues formed between the side walls of the muffle and those of the furnace, and flues extending longitudinally beneath the floor and having communication with the vertical flues, the communicating flues constituting passages around the muffle for conducting products of combustion to the secondary chambers. (*Ceram. Abs.*, **1**, 188 (1922); *Chem. Abs.*, **16**, 151 (1922).)

***Frehafer, M. K.**

EFFECT OF SUBSTITUTES FOR TIN OXIDE ON THE OPACITY OF WHITE ENAMELS FOR SHEET STEEL. See Danielson, R. R. (this *Bibliography*, p. 85).

Frink, R. L.

CHEMISTRY OF OPAQUE GLASS AND ENAMEL. *Chem. Eng.*, **10**, 128.—A criticism of the work of Enequist. F. claims that the opaque color is due to crystals formed during the cooling process. (*Chem. Abs.* **3**, 3001 (1909).)

Frisk, Samuel H.

WORK HOLDER FOR ENAMELING. U. S. Pat. 733,831, July 14, 1903.—In a work holder for enameling, two shafts arranged one within the other, a casing carried by one of the shafts, a work-engaging head carried by the casing, gear connections between the head and the other of the shafts, yielding fingers attached to the head, and an expanding device for the fingers.

Frissell, N. E.

ENAMELING PROCESS FOR CAST-IRON SANITARY WARE. *Foundry*, **41**, 220 (1913).—Résumé of methods and formulas with some information on equipment and manufacturing costs. A formula for a ground coat, which has given excellent results, is given as sand 44 lbs., borax 18 lbs., and saltpeter 14 oz. This mixture is fused and then is ground with an addition of 9% by weight of quartz and 12% of clay. The finish coat formula is given as:

Feldspar	39 lbs.	Fluorspar	9 lbs.
Sand	31 lbs.	Whiting	4 lbs. 9 oz.
Borax	31 lbs.	Zinc oxide	6 lbs.
Soda ash	24 lbs.		

This is thoroughly fused and mixed and then is ground with 14% of tin oxide, 7% zinc oxide, and 7% clay. (*Chem. Abs.*, **7**, 3209 (1913).)

Frommel, Wilhelm

SOME OLD DIRECTIONS FOR MAKING THE PURPLE OF CASSIUS AND VITREOUS ENAMEL PIGMENTS. *Chem. Ztg.*, **48**, 777.—Directions for making various preparations used in the art glass industries, contained in a manuscript dated 1835, are quoted literally. Urine is prescribed as the reducing agent for making Cassius purple. Yellow glaze consisted of red lead and sand, green glaze of MnO_2, Pb_3O_4, and sand. (*Chem. Abs.*, **19**, 870 (1925).)

Frost, L. J.

ACTION OF ACETIC ACID SOLUTIONS OF DIFFERENT STRENGTHS ON A SHEET-STEEL ENAMEL. *Jour. Amer. Ceram. Soc.*, **1**, 422 (1918).—Procedure similar to that used by Landrum, and results also somewhat in accord. The dishes for this purpose were prepared by coating small basins, first, with a coat of ground and then a thin coat of white enamel. Over these was applied a good coating of the glaze to be tested. The molecular formula of this glaze was:

$$\left.\begin{matrix} 0.885\ Na_2O \\ 0.085\ K_2O \\ 0.015\ CaO \\ 0.015\ MnO \end{matrix}\right\} \quad 0.263\ Al_2O_3 \quad \left\{\begin{matrix} 2.291\ SiO_2 \\ 0.452\ B_2O_3 \\ 0.701\ F_2 \end{matrix}\right.$$

The enamel frit was milled with 8% Vallender clay and 1% $MgSO_4$. See this *Bibliography*, p. 239, for graph of results obtained. Discussion by J. B. Shaw, E. P. Poste, B. A. Rice, and R. R. Danielson. (*Chem. Abs.*, **13**, 175 (1919); *Chem. and Ind.*, **38A**, 107 (1919).)

***Frost, L. J.**

TITANIUM ENAMELS. See Landrum, R. D. (this *Bibliography*, p. 193).

Fry, A. T.

SUPPLEMENTAL THEORY OF FINE GRINDING. *Chem. Eng. Min. Rev.*, **15**, 388 (1923).—In grinding material in a ball mill it was discovered that at a certain point of

time a very marked loss in efficiency occurred. This is intimately related to the angle of nip (approximately 30°), as in the case of roll crushing. For a given diameter of flint one can calculate the diameter, d, of the contact area which would result were the feed composed of a particular size, P, and for a given number of flints of a certain average diameter the available contact area for crushing depends on the size of the feed particles available up to the maximum permitted by the angle of nip. Thus, the maximum diameter of particle nipped (angle of nip = 30°), $P = 0.07R$, where R = radius of the flint; and the diameter of the contact area, $d = 2(\sqrt{RP + (P^2/4)} - 0.00907\ R)$. As contact area is diminished the energy of impact will be concentrated on an area too small to hold sufficient rock to absorb the energy efficiently in the resulting comminution; therefore, the smallest effective flints should be used, and still smaller steel balls may be preferable. Experimental results are reported showing the relationships among above factors, energy consumption, etc. (*Ceram. Abs.*, **4,** 84 (1925).)

Fuels and Furnaces, **2,** 1283 (1924).

WASTE HEAT RECOVERED IN DRYING VITREOUS ENAMEL.—A sheet metal recuperator in the furnace furnishes heat for the drying oven. (*Ceram. Abs.*, **4,** 99 (1925).)

Fuels and Furnaces, **3,** 153 (1925).

HEAT INTERCHANGER DRIES ENAMEL FRIT.—Description of installation by Drying Systems, Inc., for utilizing waste heat from smelter for drying frit. Capacity is 750 lbs. in 45 min. (*Ceram. Abs.*, **4,** 184 (1925).)

Fuels and Furnaces, **5,** 155 (1927).

DETROIT'S MODERN PORCELAIN ENAMELING PLANTS.—A brief description of four distinct types of wet-process plants, each characteristic of the type of work produced and the fuel used (illustrated). (*Ceram. Abs.*, **6,** 169 (1927).)

Fuels and Furnaces, **5,** 649 (1927).

INTERMITTENT FIRED ENAMELING FURNACE.—A description is given of a recently installed, intermittently fired, enameling furnace used in the manufacture of enamel iceboxes. The furnace is fired from the rear directly into the working chamber, all of the combustion gases passing to the front of the furnace and then through vents in the floors to the flues leading to the recuperation and stack. This arrangement permits the use of low pressure, air type burners, and direct and immediate absorption of the heat by the most effective, reradiating surfaces takes place. Deep wells and pits into which the ware may fall are eliminated and compensation is made for the cooling effect caused by the opening of the door. Purging to produce an oxidizing atmosphere is accomplished positively with the door closed by injecting a charge of clean, preheated air under pressure from the recuperator. Another feature is a power-operated door of unique design. Automatic devices control all of the operations aside from the handling of the charging fork, the main air-control valve for the door, and the hand-wheel control of the rotary mechanism controlling all the firing operations of the furnace. Combustion is very rapid and extremely high flame temperatures are maintained. (*Ceram. Abs.*, **6,** 266 (1927).)

Fuge, C. A.

ENAMELING METALS. British Pat. 8767, April 5, 1898.—The articles to be enameled are first heated in a suitable stove and are then immersed in a bath of molten glass enamel, or the molten enamel is swilled or poured over them while hot from a ladle. (*Chem. and Ind.*, **18,** 372 (1899).)

Fukudo, T.

MARINE BLUE PIGMENT FOR ENAMELING. *J. Jap. Cer. Assn.*, **348,** 432 (1922).—Marine blue color of enameled ware is usually produced in Japan by adding copper oxide to raw batches. Since various difficulties have been experienced by enamelers in such a method, its improvement is needful. A German pigment which is added at the mill in the manufacture of marine blueware was analyzed with the result: 32.44% alumina, 4.64% silica, 1.28% magnesia, and 0.60% moisture and loss on ignition; a similar pigment made by heating a batch of 33 cobalt oxide, 24 chromic oxide, 35 alumina, 2 stannic oxide, 1 magnesia, and 5 silica to cone 13 was almost as bright as the imported one. The shade of the pigment can be easily controlled. The effects of the introduction of various substances to the raw batch of pigment upon clarity of the color are described; in short, the addition of stannic oxide, antimony oxide, or bone ash makes the color clear, while zinc oxide, magnesia, lime, and silica tend to make the color dark or gloomy. The most economical method is in the utilization of impure alumina which is obtained as residue in the process of extracting alum from calcined alunite; the alumina used in the experiments had 65.33% alumina, 28.50% silica, 2.46% sulphuric anhydride, 0.67% ferric oxide, 1.25% lime, and 1.80% potash. A pigment made by heating a mixture of 55 impure alumina, 26.1 cobalt oxide, and 18.9 chromic oxide to cone 13 or 15, was as excellent as that imported from Germany. In enameling, 2% of pigment is added at the mill. (*Ceram. Abs.*, **1,** 294 (1922); *Chem. Abs.*, **16,** 3535 (1922).)

Fukudo, Yutaka

STUDY OF CAST-IRON ENAMELS. *Osaka Ind. Lab. Bull.*, **4,** No. 2 (1923).—The process of enameling cast-iron ware in single coat is described. (1) *Raw materials used:* Cast-iron pieces containing 2.51% carbon, 1.99% silicon, 0.10% sulphur, 0.06% phosphorus, and 0.34% manganese were employed. Enamel materials were quartz, red lead, cryolite, soda-ash, and sodium nitrate. (2) *Cast iron:* Four kinds of cast iron, ranging in the content of carbon from 2.58 to 3.13% gave almost same results for same glazes. (3) *Fusibility of enamel:* 510°C is the most suitable melting point for the purpose. (4) *Coefficient of expansion:* Experiments with 35 different batches show that enamels with expansion coefficient of 0.0000220 to 0.0000280 are most suitable. (5) *Opacifier:* Cryolite makes an enamel fragile when it is used in excess of 15%. If stannic acid is used, it should be introduced to an enamel when its frit is ground. (6) *Glazing process, time of firing:* Employing an enamel as

$$\left\{\begin{matrix} 0.112\ Na_2O \\ 0.337\ PbO \\ 0.551\ {}^1/_3\ Na_3AlF_6 \end{matrix}\right. \qquad \left.\begin{matrix} 1.242\ B_2O_3 \\ 1.526\ SiO_2 \end{matrix}\right\}$$

composed of 25 quartz, 20 red lead, 40 boric acid, 10 cryolite, and 5 sodium nitrate. F. got the best results when the enamel was fired at 750 to 770°C for 30 to 10 seconds after applying its dry powder on hot test pieces, previously heated at above temperatures for 2 to 4 minutes, or when the enamel was fired at 800 to 820°C for 40 to 10 seconds after applying its powder on hot test pieces which had just been heated at the same temperatures for 1 to 3 minutes. (7) *Surface treatment of cast-iron body:* Surface decarbonization of cast iron prevents the bubbling of enamel. An excellent result was obtained with test pieces, which had been coated with ferric oxide, manganese dioxide, or sodium nitrate, placed in a muffle, heated to 850°C, and then cooled very slowly. (8) *Colored enamel:* The batch described in (6) gave excellent colored enamels when suitable amounts of colorants were used. For example, 3 copper oxide, 3 chromium oxide, 3 manganese dioxide, and 0.5 cobalt oxide produce a light sky blue, a dark green, a dark brown, and an indigo blue, respectively. (*Ceram. Abs.*, **2,** 241 (1923); *Chem. Abs.*, **17,** 3590 (1923).)

Fuller, T. S.

PENETRATION OF IRON BY HYDROGEN. *Gen. Elec. Rev.*, **23,** 702 (1920).—The penetration of H into iron was found to be as high when exposed to 1% sulphuric acid solution as when made the cathode during an electrolysis with a similar solution. At 20°C, 2 cc. of H penetrated a seamless iron tube, 12 inches long by $^{11}/_{16}$ inch outside diameter and $^{1}/_{16}$-inch wall, during 48 hours. Passage of H through iron is apparently facilitated by the presence of a coating of tin and retarded by one of zinc or copper. One per cent potassium bichromate added to sulphuric acid prevents the passage of H through iron for at least 96 hours. (*Jour. Amer. Ceram. Soc.* (Abs.), **4,** 871 (1921).)

***Fulton, C. E.**

EFFECT OF ACIDS AND ALKALIS UPON CLAY IN THE PLASTIC STATE. See A. V. Bleininger (this *Bibliography*, p. 27).

Fusselbaugh, R. R.

EFFECTS OF VARYING SODA AND BORIC OXIDES IN GROUND-COAT ENAMEL. *Jour. Amer. Ceram. Soc.*, **10,** 270 (1927).—Variations were made from 5 to 25% in soda oxide and boric oxide content of a given ground-coat enamel, and results were observed on trial pieces. It was found that an increase of soda oxide at the expense of boric oxide decreased the tendency of the enamels to blister and fishscale, and increased the tendency toward the formation of copperheads. Conversely, the increase of boric oxide at the expense of soda oxide increased the tendency of the enamels to blister and fishscale, but decreased the tendency to copperhead. (*Ceram. Abs.*, **6,** 212 (1927); *Chem. Abs.*, **21,** 1876 (1927); and *Chem. and Ind.*, **46B,** 442 (1927).)

Fusselbaugh, R. R., and Sweely, B. T.

METHOD OF CONTROL OF ENAMEL FOR DIPPING WARE. *Jour. Amer. Ceram. Soc.*, **8,** 303 (1925).—Development of varying specific gravity to control the dipping consistency of ground coat. The necessity of constant mill load and milling. Most efficient milling reached when $^{1}/_{2}$% glass was retained on 150-mesh screen. The best results were obtained on samples whose milling time was from 20 to 24 hours. On a preliminary run it was found that a slip weighing 3.85 pounds per liter gave the best results. This weight for the slip was then used in the following experiments. (*Enamelist*, **2** [5], 7 (1925); *Chem. Abs.*, **19,** 1935 (1925); *Chem. and Ind.*, **44B,** 548 (1925).)

Gallus

COOKING VESSELS WITH LEAD-CONTAINING AND LEAD-FREE GLAZES. *Tonind.-Ztg.*, pp. 51, 85, 93, 108 (1877); *Rep. der Tech. Lit.*, p. 76 (1877).

Gant, T. H.

COBALT: ITS PRODUCTION AND USES. *Chem. and Ind.*, **44,** 157 (1925).—Cobalt occurs in the following forms, of which smaltite, cobaltite, and asbolite are the most important: cobaltite or cobalt glance, CoS_2, $CoAs_2$; smaltite, $CoAs_2$; linnalite or cobalt pyrites, CoS, Co_2S_3; erythrite or cobalt bloom, $Co_3As_2O_8$, 8 H_2O; willyamite, CoS_2, NiS_2, $CoSb_3$, $NiSb_3$; skutterudite, $CoAs_3$; asbolite, an impure mixture of Mn and other metallic oxides containing up to 30% CaO; spacerocobaltite, $CaCo_3$, and its hydrate remingtonite; safflorite, $CoAs_2$; glancodot (CoFe), AsS. The chief sources of supply are Cloncurry, Queensland, and Nipissing, Ont. Speiss from Nipissing residues contains 17.55% Co, 18.82% Ni, 12.04% Fe, 8.15% Cu, 0.91% Ag, 6.69% S, 35.14 As. Speiss from Australian ores contains 43.14% Co, 1.0 Ni, 10.0 Fe, 30.03% As, 15.04% S. As prepared for commerce, cobalt "black oxide" contains 70% Co, "special oxide" 72% Co, and "prepared oxide" 75% Co. Nickel hydrate is recovered as a by-product, roasted

and graded as: "OG" containing 68 to 70% Ni; "G" 73% Ni; DR 73 to 76% Ni. The "black oxide" of Ni contains 76 to 77% Ni. Ferro-cobalt is marketed in cubes containing 10 to 15% Fe and 80 to 90% Co for use in the iron and steel industry. Thenard's blue is $CoO \cdot Al_2O_3$; Rinan's green, CoO·ZnO mixed with ZnO. Margarine blue is obtained by calcining 68 parts CoO, 16 Cornish stone, 12 flint, 4 whiting. $BaCO_3$ may be substituted for $CaCO_3$, and ground pitchers introduced as well. Colors are most resistant to the action of the glaze if built up on the spinel type $RO \cdot R_2O_3$; *e.g.* $(4CoO \cdot 6ZnO)Al_2O_3$. The defect of "ironing" may be remedied by adding Al_2O_3 or TiO_2. "Flows blue" is obtained by putting white lead and salt in the saggers with the cobalt glazes. In pottery bodies, CoO acts as a whitener in the proportion of 1:2240 parts of dry body. It is best first ground with 10% china clay. (*Ceram. Abs.*, **4**, 150 (1925).)

Garchey, L. A.

PROCESS OF ENAMELING. French Pat. 321,333, May 21, 1902.—An even coating of enamel or glaze is obtained by stirring the powdered glaze in a liquid in which it is insoluble, and afterward placing the plate in this liquid to receive the powder as it falls. When sufficient glaze has been deposited, the liquid is siphoned off. (*Chem. and Ind.*, **22**, 298 (1903).)

***Gardner**

See Bingham, E. C. (this *Bibliography*, p. 24).

Gardner, H. A., and Holdt, P. C.

MEASUREMENT OF CONSISTENCY OF VARNISH. Paint Manuf. Assn. of U. S., *Circ.* No. 127 (1921).—The authors define viscosity, plasticity, rigidity, and viscous and plastic flow. Absolute viscosities obtained with the Bingham variable pressure plastometer fitted with a modified receiver, on 37 different varnishes of various types ranged from 0.6 to 5.5 poises at 25°; these are tabulated against results obtained with the MacMichael and Doolittle torsion viscometers. Details of the operation of the instruments, calculation of the capillary constant of the plastometer, discussion of accuracy, etc., are given. The MacMichael operated at accurately controlled low speeds and temperature might be used for research and routine work, but it is not as accurate as the plastometer and exhibits a tendency to indicate viscosities lower than the true values. The Doolittle appears best adapted for routine testing although its readings cannot be calculated to absolute viscosities. The Stoermer and the Hadfield-Bawtree viscometers are described. The occurrence of plasticity in varnishes cannot well be explained on the hypothesis of solid friction, because ultramicroscopic examination shows very few solid particles; but it may be due to emulsoid aggregates forming a continuous structure through the varnish. (*Ceram. Abs.*, **1**, 7 (1922); *Chem. Abs.*, **14**, 1047 (1920); *ibid.*, **15**, 180 (1921).)

Garros, F.

FURNACE FOR POTTERIES, GLASS WORKS, ENAMELING OF METALS, AND SIMILAR INDUSTRIES. French Pat. 394,666, Sept. 5, 1908; British Pat. 20,400, Sept. 6, 1909.—In order to raise the temperature of the furnace rapidly, the door is movable, and the channels are provided in the thick part of it, for the circulation of hot or burning gases. There is also a box-sagger with double walls, between which a layer of air is enclosed. In the case of furnaces in which the saggers are surrounded on all sides by fire holes, the heat of the combustible is utilized to a most complete extent, a fire hole being arranged in the thick part of the door, and the products of combustion passing round suitable channels, by which the air-supply for the grates enters, in such a way that the air can be preheated, as desired, before passing through the fuel. (*Chem. and Ind.*, **28**, 310 (1909).)

Garve, T. W.

SEGREGATION IN BINS. *Jour. Amer. Ceram. Soc.*, **8,** 666 (1925).—The formation of a cone in filling a bin causes ground materials to segregate. We have shown that bins will empty first through the center where the fine material is located and that the sides, where the coarser particles are, will follow through the center afterward. This takes place regardless of the shape or the angle of the hopper bottom within practical limits. A retarder in center will somewhat correct segregation. To overcome segregation fully, the aforementioned cone formation must be avoided.

Gates, A. O.

POWER-LOAD CURVES OF BALL MILLS. *Eng. Min. Jour. Press,* **113,** 485 (1922).—A simple laboratory apparatus for experimental work shows that power varies directly with the charge up to half load, reaching a maximum at 60 to 75% of the mill capacity. A curve is shown for a cylindrical mill at various speeds and loads. Power in ball mills is consumed as (*a*) friction losses in bearings, and (*b*) energy spent upon the free balls or pebbles within the mill and by them spent upon the ore, or other pebbles, or in the lining, or returned to the mill. The friction load is practically constant for all loads at constant speed. The horse power developed by the mill in raising the balls equals $R^{4/3}$ = a constant, when R = radius of mill. (*Ceram. Abs.*, **3,** 292 (1924).)

Gehring, G.

ENAMELING METAL CASTINGS IN THE MOLD. German Pat. 19,255, July 22, 1881.—The molds are covered with an isolating layer, consisting of a mixture of finely-ground talc, charcoal, and paraffin oil. This is covered with an enameling solution consisting of three parts of magnesium sulphate and two parts magnesium oxide in 100 parts of water, whereupon the enameling mass is sieved over it. (*Chem. and Ind.*, **2,** 178 (1883).)

Gehring, G.

IMPROVEMENTS IN AND RELATING TO ENAMEL FOR METALS, GLASSWARE, EARTHENWARE, ETC. British Pat. 8090, May 11, 1891.—These improvements relate to various compositions used for the production of enamels. One particularly fine enamel is said to be produced by using graphite, cold-pressed Hungarian linseed oil, and oxide or borate of lead. G. claims the

process for enameling metals, earthenware, and glassware, consisting in mixing a powder of graphite, coke, slag, alum, and kaolin, or one or more of these materials, with a flux, rubbing up the mixture with a compound obtained by boiling linseed oil with an oxide or a borate of lead, and laying on, drying, and firing the same.

Powdered kaolin may be mixed with a flux and the mixture "rubbed up" with water, afterward laying on, drying, and firing. (*Chem. and Ind.*, **10,** 1007 (1891).)

Geisinger, E. E.

AN EXPERIMENT IN ELECTRIC SMELTING GLASS ENAMEL. *Jour. Amer. Ceram. Soc.*, **5,** 248 (1922).—Operating economies will require smelting of enamel frits in electric furnaces. A refractory enamel containing high content of metallic oxides was smelted in a combination arc and carbon resistor furnace, obtaining complete fusion without reduction of oxides or change in character of the enamel. Tests were run on charges of about 400 grams. (*Chem. Abs.*, **16,** 2763 (1922); *Chem. and Ind.*, **41A,** 465 (1922).)

Geisinger, E. E.

MICROSCOPIC STUDY OF GROUND-COAT AND COVER-COAT ENAMEL REACTIONS. *Jour. Amer. Ceram. Soc.*, **5,** 322 (1922).—(1) The degree of susceptibility of enamels to furnace gases is easily classified by cross-section examination under the microscope. (2)

The excess intermingling of ground coat and cover coat, meaning that their flowing temperatures are too close to one another, as well as possible interaction between ingredients, can be determined. The lack of firing range of either ground or cover coat can easily be noted. (3) The tendency of a continued excess gasifying of the enamel on the ware especially at high temperatures will be seen, as in the case of enamels containing high titanium oxide. (4) The high viscosity of enamels which does not allow the ready escape of occluded air and gases, thereby forming large bubbles and a resulting weak structure, can be studied. The very opposite of this condition, causing very dense glasslike structure, can be studied. (5) And, finally, the relation of all these factors in helping to explain characteristic fishscaling and shivering, which were summarized under the heading "overfired." Microphotos of results, and tables showing composition of enamels studied are included. A discussion of this paper is presented by B. T. Sweely, *Bull. Amer. Ceram. Soc.*, **1,** 112 (1922); R. R. Danielson, *ibid.*, p. 161, and E. P. Poste, *ibid.*, p. 162. (*Chem. Abs.*, **16,** 2763 (1922); *Chem. and Ind.*, **41A,** 633 (1922). See also this *Bibliography*, p. 37, and Sweely, B. T., p. 304.)

***Geitner and Co.**

OLDEST ENAMEL COLOR WORKS IN GERMANY. See *Chem. and Ind.* (this *Bibliography*, p. 64).

Geller, R. F.

BUREAU OF STANDARDS INVESTIGATION OF FELDSPAR. *Ceramist*, **6,** 708 (1925).—G. reports the progress of the investigation of the factors affecting glaze hardness. Glazes to be tested are abraded by a falling stream of sand and the amount of surface worn away by a definite weight of sand is determined by an Ingersoll glarimeter. Preliminary data are given in the form of a graph. The feldspar investigation is divided into two parts. The first part consists of a comparison of tests for softening point, fusion point, chemical analysis, fineness as carried out by coöperating laboratories, and the Bureau. The second part includes studies of viscosity of feldspar at softening temperatures, and the effect of feldspar on the firing range, porosity, color, and strength of vitreous and semivitreous bodies. Petrographic examinations are given in all cases. G. reports outcome of studies on fineness, chemical analysis, and quartz content to date. (*Ceram. Abs.*, **5,** 38 (1926); *Chem. Abs.*, **20,** 806 (1926).)

Geller, R. F.

BUREAU OF STANDARDS INVESTIGATION OF FELDSPAR: SECOND PROGRESS REPORT. *Jour. Amer. Ceram Soc.*, **10,** 411 (1927).—The history and purpose of the investigation are outlined and detailed reports are made on (1) the results of air elutriation and coöperative sieve and chemical analyses of the nineteen feldspars being studied, (2) cooperative determinations of softening point, and (3) true specific gravity. The paper also includes a report on tests of mechanical strength, light transmission, porosity, volume shrinkage during firing, and thermal expansion of whiteware specimens in which the feldspars being studied were the only variable component. (*Ceram. Abs.*, **6,** 291 (1927); *Chem. Abs.*, **21,** 2967 (1927).)

Genders, R.

INTERPRETATION OF MICROSTRUCTURE OF CAST METALS. *Engineering*, **122,** 88 (1926).—When a mold is filled with liquid metal, solid crystals first form in contact with the mold and grow inward at right angles approximately to the surface. Because each crystal is confined laterally by similar crystals, their shape becomes columnar; these are known as chill crystals. Should the casting temperature be sufficiently low, or the rate of solidification slow enough, isolated centers of crystallization form in the interior and grow radially to form, roughly, equiaxed ("free") crystals. The relative

proportions of columnar and "free" crystals give definite indication of the initial temperature of the metal and of the rate of cooling, which latter is determined by the mold. It is generally recognized that the most desirable microstructure is one consisting entirely of "free" crystals, and accordingly the lowest possible casting temperature is used, especially for some alloy steels which are particularly apt to crack along diagonal planes during cooling. In very large castings, where cooling is slow, a high casting temperature is permissible, and advantageous in eliminating suspended inclusions of nonmetallic matter. Defects in iron castings which are connected with microstructure consist of irregular-shaped interdendritic cavities due to shrinkage, and planes of weakness due to solidification of low melting point impurities between the dendrites; these also occur along diagonal junctions which are formed by the convergence of chill crystals growing from adjacent faces of the mold, and, at the bottom of the casting, on pyramidal planes. Blowholes due to the liberation of gas on freezing are distributed throughout the casting, but one type of blowhole, found near the surface, is related to microstructure since it is produced in top-poured ingots by interaction of carbon in the iron with the oxide formed on metal splashed against the wall. G. then discusses nonferrous alloys, and states that indications to be gained from iron castings when applied to brass, etc., would only be true to a limited extent, *e.g.*, it is not always possible to reconstruct from the microstructure the conditions of castings. (*Ceram. Abs.*, **6,** 9 (1927).)

General Electric Co., Ltd.

GLASS AND ENAMEL. British Pat. 223,837, June 24, 1923.—Glasses or enamels of low melting point are formed of the following composition (by molecular proportions): PbO 1, B_2O_3 0.45 to 0.55, SiO_2 0 to 2.0, Al_2O_3 0.04 to 0.20, Na_2O 0.04 to 0.07, K_2O 0.01 to 0.02, As_2O_3 0 to 0.01 and Co_2O_3 0 to 0.04. The Co_2O_3 may be replaced by other coloring or opacifying agents. These compositions melt generally at 360 to 400° and are suitable for marking electric lamp bulbs and for use as an adhesive between metal, glass, porcelain, and other material or for coating glass or metal articles. (*Ceram. Abs.*, **4,** 156 (1925); *Chem. Abs.*, **19,** 1183 (1925); and *Chem. and Ind.*, **43B,** 1013 (1924).)

General Electric Co., Ltd.

ENAMELS AND GLASS. British Pat. 14,532 (1924).—Glasses or enamels having a low melting point consist of a lead borate or lead borosilicate composed of a number of constituents in accordance with the following molecular composition: PbO,1; B_2O_3, 0.45 to 0.55; SiO_2, 0 to 0.20; Al_2O_3, 0.04 to 0.20; Na_2O, 0.04 to 0.07; K_2O, 0.01 to 0.02; As_2O_3, 0 to 0.01; Co_2O_3, 0 to 0.04. The Co_2O_3 may be replaced by other coloring or opacifying agents. The mixture fuses at a temperature below 400°C, generally between 360°C and 400°C. These enamels are suitable for marking electric lamp bulbs, their low fusing point preventing the thin glass bulbs from becoming deformed while the enamel is being fired on. They are also suitable for use as an adhesive between metal, glass, porcelain, etc. They may be used, also, for coating metal or glass bodies by heating the bodies and dipping them while hot into the powdered enamel. Specification 28524/03 is referred to. (*Ceram Abs.*, **4,** 255 (1925).)

General Electric Co., Ltd.

GLASSES AND ENAMELS. British Pat. 233,295, Oct. 14, 1924.—The glasses and enamels described in British Pat. 223,837 are made more resistant to chemical action by increasing the SiO_2 content. The B_2O_3 content is decreased at the same time, to maintain the desired low melting point, and the alkali oxides are preferably replaced in part at least by other oxides such as those of zinc, magnesium, calcium, barium, or lithium which reduce the coefficient of expansion. The products may comprise: PbO 1, ZnO (or Al_2O_3, CaO, MgO, or BaO) 0.04 to 0.15, SiO_2 0.3 to 0.6, Li_2O (or Na_2O

or K_2O) 0.04 to 0.15, B_2O_3 0.23 to 0.35, and coloring oxide 0 to 0.1 parts. Fluorides such as CaF_2 may be used for producing opaque enamels and refractory oxides and salts of metals may be added. (*Ceram. Abs.*, **5,** 153 (1926); *Chem. and Ind.*, **44B,** 548 (1925); *Chem. Abs.*, **20,** 650 (1926).)

General Electric Co., Ltd.

READILY FUSIBLE GLASSES AND ENAMELS. British Pat. 267,815, Sept. 25, 1926. (Assess. of Patent, Treuhand-Ges. für Elektrische Glühlampen m.b.H).—Glasses with a low coefficient of expansion and without yellow coloration, for coating glass articles by fusion, have the following limiting composition, 60 to 75% of lead oxide, 10 to 25% of zinc oxide, and 15 to 30% of boric oxide, the most suitable formula being 65% of lead oxide, 15% of zinc oxide, and 20% of boric oxide. They may be made opaque by adding up to 2% of arsenic and up to 2% of an ammonium compound. (*Chem. and Ind.*, **46B,** 365 (1927).)

Generals des Cables de Lyon Compagnie

ENAMELED WIRE. British Pat. 213,885, April 5, 1923.—Copper or other wires for electrical or other purposes are coated with silver or a similar ductile metal before they are drawn and enameled. A smooth finish is thus obtained. (*Chem. Abs.*, **18,** 2413 (1924); *Chem. and Ind.*, **44B,** 549 (1925).)

***General Stamping Co.**

MANUFACTURE OF GRAY ENAMELED WARE. See *Iron Age* (this *Bibliography*, p. 160).

Genie, **30,** p. 31.

GLAZES WITHOUT SOLUBLE METAL OXIDES, BORAX, SODA, SEA-SALT. (*Rep. der Tech. Lit.*, p. 306 (1854–1868).)

Gerber, Albert C.

USE OF GELATIN IN GLAZE APPLICATION. *Jour. Amer. Ceram. Soc.*, **7,** 494 (1924).—Painting with gelatinized glaze offers distinct advantages. A high-grade hide gelatin should be used and careful regulation maintained in all steps of the process. High clay mixtures gelatinized with greater difficulty than those whose contents of ground material are large. Loss from rubbing or chipping of glaze becomes a minimum. (*Chem. Abs.*, **18,** 3262 (1924).)

Ges. fur Tuff- und Ton Technik m.b.H.

PREPARATION OF ENAMELS AND CERAMIC GLAZES AND OF A FELDSPAR SUBSTITUTE FOR CERAMIC BODIES. German Pat. 395,824, Nov. 11, 1921.—Suitable raw materials, *e.g.*, igneous rocks, artificial slags, etc., are decomposed by treatment with alkalis or other chemical reagents (if necessary, with the addition of organic colloids), under high temperature and pressure. The raw materials may be subjected to a preliminary mechanical disintegration. The process aims at the elimination of the grinding operation. (*Chem. and Ind.*, **43B,** 830 (1924).)

Gew. Bl. Wurt, **41,** pp. 330, 337, 346.

TECHNIQUE OF ENAMELING. (*Rep. der Tech. Lit.*, p. 118 (1888–1890).)

Gibson, A. H., Lea, F. C., and Griffiths, Ezer

EFFECT OF ENAMEL ON THE TRANSMISSION OF HEAT. Repts. Light Alloys Sub. Comm., Advisory Comm., for Aeronautics, No. 5, p. 61 (1921); *J. Inst. Metals*, **28,** 632.—The rate of flow of heat from a rough cast aluminum surface to the air or to water is considerably improved if the surface is coated with a smooth enamel. A large number

of tests showed that the best results are obtained with a hard, smooth, stove enamel, which increases the rate of transmission of heat from a rough cast aluminum alloy surface to air by 15%, to water by 4 to 8%, from cast iron to air by 7%, and from steel to air by 2%. No effect is produced on copper. (*Ceram. Abs.*, **2,** 242 (1923).)

***Gilchrist, Benjamin W.**

ENAMELING METALLIC ARTICLES. See Rice, George L. (this *Bibliography*, p. 256).

Gill Technol. R., **1,** 342; **2,** 5.

ENAMEL COLORS. (*Rep. der Tech. Lit.*, p. 272 (1823–1853).)

Gill Technol. R., **2,** 1.

FRENCH PROCESS FOR MAKING ENAMELED DIALS. (*Rep. der Tech. Lit.*, p. 272 (1823–1853).)

Glaser

CONCERNING INTERNAL FRICTION OF VISCOUS AND PLASTIC BODIES AND THE VALIDITY OF POISEUILLE'S LAW. *Ann. Phys.*, **22,** 694.

Glashütte, **13,** 52 (1883).

GLASS COVERING ON METALS. (*Rep. der Tech. Lit.*, p. 119 (1882–1884).)

Glashütte, **41,** 604, 649 (1911).

GREEN ENAMELS FOR GALVANIZED IRON.—General directions are given for enameling and the following formulas. For the first layer and enamel, SiO_2 500, borax 375, feldspar 330, MgO 200. If it is desired to lower the melting point the feldspar content may be increased. The enamels may be colored green by adding a thorough mixture of smalt 125 and Naples yellow 100. The latter is prepared by roasting Sb_2O_4 100 and PbO 75. A dark green is produced by CoO 100, Naples yellow 50, MnO_2 10 to 20. Nankin yellow may be used to vary the green shade as for example, CoO 100, Nankin yellow 40, Naples yellow 35. To obtain a light yellow-green Cr_2O_3 50 and Naples yellow 20 to 35 may be used. A pleasing green is also given by the addition of one part or slightly less of CuO to five parts of the enamel mixture. Small amounts of iron oxide may be added to brighten the green. (*Chem. Abs.*, **5,** 3503 (1911).)

Glashütte, **41,** 811, 839, 864 (1911).

VARIOUS PROCESSES FOR DECORATING ENAMELED WARE. (*Chem. Abs.*, **6,** 142 (1912).)

Glashütte, **43,** 326 (1913).

REMOVING ENAMELS.—The use of sodium hydroxide at 180° with 12 atmospheres pressure is suggested. One part sodium hydroxide attacks successively five parts of enamel. (*Chem. Abs.*, **7,** 3004 (1913).)

Glashütte, **51,** 131, 147 (1921).

NEW MEURER ENAMEL SPRAYING PROCESS.—A modification of the Schoop spraying gun or nozzle. (*Ceram. Abs.*, **1,** 85 (1922); *Chem. Abs.*, **15,** 2703 (1921).)

Glenner, F. R.

ZIRCONIA IN ENAMELS. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 41).

***Globe Stove Co.**

GLOBE STOVE INSTALLS UP-TO-DATE ENAMELING PLANT. See *Enamelist* (this *Bibliography*, p. 107).

Gnüchtel, G.

IMPROVEMENTS RELATING TO THE MARBLING OF ENAMELED ARTICLES. British Pat. 3034, Feb. 16, 1892.—Hitherto enameled kitchen utensils have been given a marbled surface by squirting a liquid upon the surface of the enamel and then shaking the vessel so as to distribute the liquid in lines or veins. This needs care and skill on the part of the operator and at best does not permit of an uniform marbling. In this invention a plate is used provided with pins or bristles which are dipped in the liquid. From the point of the bristles drops of uniform size are deposited on the enamel in a regular manner. By gently knocking the utensil the drops are caused to run out into veins or lines, and a uniform marbling is thus produced. (*Chem. and Ind.*, **11,** 524 (1892).)

Godin

ENAMELING OF STEEL AND IRON. *Publ. ind.*, p. 506 (1876). (*Rep. der Tech. Lit.*, p. 54 (1876).)

Goerens, P., and Jungbluth, H.

HARDNESS OF CHILL CAST IRON. *Stahl u. Eisen,* **45,** 1110 (1925).—The shore hardness number of chill cast iron increases in direct proportion to carbon content from 56 to 2.4% carbon to 84 at 4.2% silicon content. The thickness of the hard outer layer varies considerably with the rate of cooling and silicon content. In general, the thicker the walls of the mold, *i.e.*, the greater the cooling on pouring, the thicker is the hard layer; and the larger the silicon content, the thinner the hard layer. With 0.3% silicon, the thickness is 60 mm.; with 0.8% silicon, 15 mm.; with 1.1 to 1.4% silicon, 0.8 to 0.6 mm. Manganese between 0.25 and 0.6% and sulphur between 0.17 and 0.068% have no influence on the hardness. (*Ceram. Abs.*, **5,** 11 (1926); *Chem. and Ind.*, **44B,** 673 (1925).)

Goetz, G. W.

REMOVING ENAMEL FROM METAL. U. S. Pat. 528,156, Oct. 30, 1894.—The process of removing enamel from metal which consists in immersing the enameled article in a molten bath of caustic alkali.

Goldschmidt, Th.

REMOVING ENAMEL AND RECOVERING THE IRON, ETC. French Pat. 418,971, Aug. 1, 1910; German Pat. 242,055 April 2, 1910.—The articles (or scrap) are first subjected to compression for the purpose of cracking the enamel and then are cut into strips. By means of appropriately constructed cleavers, the strips are opened sufficiently to allow the broken enamel to fall away from between the layers. (*Chem. and Ind.*, **30,** 92 (1911); *Chem. Abs.*, **6,** 2157 (1912).)

Goldschmidt, Th.

FRITS USEFUL IN THE MANUFACTURE OF ENAMELS OR GLASSES. French Pat. 439,609, Feb. 1, 1912; *La Céramique,* **16,** 12(1913).—The precipitate of the oxyhydrate of tin from solutions of alkali stannate always contains alkali, which cannot be washed out by cold water. 4.2% Na_2O is regarded as chemically combined with the oxyhydrate of tin, as it can only be extracted by calcination, treatment with acids, or continued boiling. A large number of comparative experiments have shown that the elimination of this Na_2O gives an oxide of tin, which cannot be used in the manufacture of enamel. The covering ability diminishes in the same ratio as the alkali content is diminished. A product containing 80 to 85% SnO_2, 8 to 14% H_2O, 3 to 5% alkali, has a covering ability 40% more efficient than the 100% pure oxide of tin commercially prepared by calcination of the metal. The precipitated oxyhydrate of tin should be washed with cold

water and dried at 100 to 140°. (*Chem. Abs.*, **7**, 1959 (1913); *Chem. and Ind.*, **31**, 723 (1912).)

Goldschmidt, V. M.

ENAMELING CERAMIC WARE. Norwegian Pat. 40,171, Nov. 3, 1924.—After it is fired for the first time the article is moistened with an aqueous solution of a boron compound and fired again. (*Ceram. Abs.*, **4**, 156 (1925); *Chem. Abs.*, **19**, 1337 (1925).)

Gosreau, R. C.

COMPARISON OF GAS AND ELECTRICITY FOR INDUSTRIAL HEATING. *Chem. Met. Eng.*, **33**, 337 (1926).—Comparison of the different methods, also the economic and commercial considerations. (*Enamelist*, **3** [9], 9 (1926).)

Gossin

ENAMELING SILVER APPARATUS. *Br. d'inv.*, **42**, 418. (*Rep. der Tech. Lit.*, p. 272 (1823–1853).)

Gossweiler, K.

MANUFACTURING CLEAN EDGES IN ENAMELED WARE. U. S. Pat. 828,107, Aug. 7, 1906.—Method of manufacturing clean edges and surfaces of enameled ware, consisting in binding or covering the parts of the ware most liable to damage, before enameling with sheet nickel, nickeled sheet steel, etc., and afterward coating the ware with enamel up to or a little over the binding or covering and finally firing the ware.

Grainer, John S.

OBSERVATIONS ON THE FACTORY CONTROL OF FISHSCALING. *Jour. Amer. Ceram. Soc.*, **5**, 95 (1922).—An analysis of fishscaling, its causes and prevention, based upon observations and experience of practical work. Three principal causes of fishscaling are: (1) Improper firing, either underfiring or overfiring, especially the latter since its effects are usually not evident until the ware is finished and marketed. (2) The use of a clay which does not give a free running uniform coat without the use of excessive amounts of flotation agents. Clays which when stirred up with water give a persistent suspension are recommended. (3) Improper type of furnace for the firing operation. G. prefers the open type furnace for the firing of enameled ware. (*Chem. Abs.*, **16**, 1140 (1922); *Chem. and Ind.*, **41A**, 253 (1922).)

***Gramm, F. G.**

OPAQUING COMPOSITION FOR ENAMELING MIXTURES. See Perino, J. (this *Bibliography*, p. 233).

***Grampp, Otto**

REFERENCE BOOKS ON ENAMELS. *Jour. Amer. Ceram. Soc.* (see this *Bibliography*, p. 166).

***Grand Rapids (Mich.) Refrigerator Co.**

A PLANT THAT IS PROLIFIC WITH UNUSUAL ENAMELING IDEAS. See *Ceram. Ind.* (see this *Bibliography*, p. 51).

SPRAYING BOOTH KEPT FREE OF ENAMEL DUST BY UNIT SUCTION SYSTEM. See *Ceramic Ind.* (this *Bibliography*, p. 58).

Granger, A.

OPAQUE AND COLORED GLASSES AND CERAMIC GLAZES OF THE SAME NATURE. *Jour. Soc. Glass Tech.*, **7**, 291 (1923).—The production of opacity by agents such as

fluorides, cryolite, stannous oxide, and arsenious oxide, and of color by agents such as selenium, cadmium sulphide, copper, etc., is considered to be due to physical, rather than chemical changes in the glass. (*Chem. and Ind.*, **43B**, 218 (1924).)

Granger, A.

ZIRCONIA, ITS USE AS A REFRACTORY, AN OPACIFIER, AND AN ABRASIVE. *Mon. sci.*, **9**, 5 (1919); *Chem. News*, **118**, 115 (1919).—As a laboratory material ZrO_2 is old (Klaproth, 1789), but as a commercial product it is very new. The various ZrO_2 ores are described and analyses of seven are given. The chief ore is zircon. The Brazilian deposit marketed by the Foote Mineral Co. is described. Laboratory processes for recovering zirconium are given. ZrO_2 fuses above 3000° and even with 1.25% $SiO_2 + Fe_2O_3$ the melting point is above 2500°. The coefficient of expansion is 8.14×10^{-7} compared with SiC = 6.4×10^{-6} and alundum = 7.1×10^{-8}. ZrO_2 is very inert chemically and even at 3000° an equimolecular mixture with SiO_2 shows very little reaction; the SiO_2 has fused and penetrated the ZrO_2. The most important reaction is its tendency to form carbide, especially in a carbon electric furnace. Its specific conductance changes with temperature from 0.0008 at 1200° to 0.0034 at 1400°. The literature on ZrO_2 as a refractory is exhaustively reviewed. The use of ZrO_2 as an opacifier has been studied but little. It is too costly for present use. The cost might be warranted if unusual resistance to acid were developed or other great advantage. As an abrasive it is not especially promising because of its chemical inactivity. The usual silicate bonds are not satisfactory and cement bonds are the only ones available. The chief future of ZrO_2 is in the field of metallurgical refractories. (*Chem. Abs.*, **13**, 1003 (1919).)

Granger, A., and Babille

RESEARCH ON GLASS OPACIFIERS. *Chimie et Industrie*, Special Number, Vol. 3, Sept., 1926.—The status of the problem and proposed theories are reviewed. Opacifiers may be divided into three groups: (1) those remaining in the glass without modification; (2) those causing opacity without loss of any element, but accompanied by chemical reaction; (3) those causing opacity by chemical reaction but with the departure of one or several elements. Examples of first group are calcium phosphate, tin oxide, zirconia, titanium oxide, arsenious, and antimonous anhydrides. Opacifiers of the second group are such as silica, alumina, boric anhydride, and zinc oxide when introduced at fusion. Among opacifiers forming the third group, those with a fluoride base are the most common. There is considerable difference of opinion as to what causes the opacity and as to how fluorine escapes. (*Chem. Abs.*, **21**, 632 (1927).)

Gravell, James H.

RUSTPROOFING BATH FOR IRON AND STEEL. U. S. Pat. 1,572,354, Feb. 9, 1926.—A bath for rustproofing comprising water, free phosphoric acid, and monosodium phosphate which combining with pickling and foreign acids opposes the formation of a sludge. (*Ceram. Abs.*, **5**, 117 (1926).)

Gravely, J. S.

REMOVING RUST FROM METALS. U. S. Pat. 1,459,910, June 26, 1923.—Rust is removed from articles of ferrous metal or nickel-plated ware by treating them with a solution of ammonium citrate or other organic ammonium salt, and then, after a lapse of time, washing off the slime produced. (*Ceram. Abs.*, **2**, 242 (1923).)

Gray, H. B.

HOURS VS. REVOLUTIONS IN GRINDING. *Enamelist*, **2** [1], 15 (1924).—G. found that variations in power caused revolutions of mills to vary from 12 to 25 per minute.

This variation in grinding gave rise to ground coat difficulties. This condition was remedied by grinding the charge for a certain number of revolutions of the mill, rather than for a set period of time.

***Green, H.**

PAINT, A PLASTIC MATERIAL. See Bingham, E. C. (this *Bibliography*, p. 23).

Green, Henry

FURTHER DEVELOPMENT OF THE PLASTOMETER AND ITS PRACTICAL APPLICATION TO RESEARCH AND ROUTINE PROBLEMS. *Proc. A.S.T.M.*, **20** [2], 451 (1920).—In the plastometer previously devised by Bingham and Green, the container is modified so that the material under test, on being forced through the capillary tube at known pressures, displaces air at a rate which is measured by a very sensitive gaseous flowmeter. Determinations of plasticity of commercial paint pastes show that their mobility varies widely while variations in yield values are not so great. Stiff, stringy pastes and all pastes containing pigments capable of being ground in a small percentage of vehicle, have low mobility. Yield value depends on the wetting of the pigment and its particle size. Tabulated determinations on greases show their high plastic nature. A good paint will have a mobility of 0.2 to 0.5 and a yield value of 0.4 to 0.8. If a paint is otherwise good, the higher the mobility the better. The instrument gives mathematical definition to the character of plastics and is applicable to routine matching of the "body" of paints, etc., and to the study of oil absorption of pigments, degree of plasticity of clays, particle size, thinning of paints and pastes on aging, livering, stringiness of pastes, effect of colloids on the properties of paints, etc. The instrument modifications are described in detail, mathematical determination of the yield value factor, and graphs and tables of results presented. Bingham shows that it is theoretically possible to measure plasticity by making only two measurements of flow through a single capillary. Mixtures with a very small pigment content appear to conform to the laws of viscous bodies, rather than to those of plastics. (*Chem. Abs.*, **15**, 1408 (1921).)

***Greene, G. W.**

NEW LEONARD PLANT, A MODEL FOR FLEXIBLE PRODUCTION. See Sealey, P. T. (this *Bibliography*, p. 275).

Greenley, C. J.

DESIGNS OR SURFACES FOR ENAMELING AND OTHER PURPOSES. British Pat. 16,486, Aug. 16, 1901.—Celluloid sheets or other flexible supports coated with gelatin are used for transferring designs to pottery, enamels, etc., in place of paper transfers. The "gelatin transfer" receives impressions in turn from lithographic stones or plates of the component shades of the design. Commencing with the darkest shade, by working chromatically using the colors, yellow, blue, and red, the most complicated design may be reproduced in three firings, each firing consisting of any number of shades of the one color. (*Chem. and Ind.*, **21**, 1183 (1902).)

Grenet, L.

BORIC ACID IN GLAZES AND ENAMELS. *Compt. rend.*, **123**, 891 (1896).—The coefficient of expansion of a glaze or enamel is sometimes increased by the addition of boric acid, and, on the other hand, is sometimes diminished, although the coefficient of expansion of boric acid itself is greater than that of any glass. G. finds that if boric acid be used in successively increased quantities, the first effect is to lower the coefficient and afterward to increase it progressively. This result appears to be connected with the circumstance that if the proportion of bases be large, devitrification occurs; whereas

if the proportion of boric acid be large, a separation of nearly pure boric acid takes place. (*Chem. and Ind.*, **16**, 144 (1897).)

***Grieveson, C. J. W.**

PORCELAIN-ENAMELED STEEL REFLECTORS. See Buckley, H. (this *Bibliography*, p. 37).

Griffiths, E.

EFFECT OF ENAMEL ON TRANSMISSION OF HEAT. See Gibson, A. H. (this *Bibliography*, p. 131.)

***Grimwade, L. T.**

CONTINUOUS MUFFLE FURNACES OR KILNS. See Dicken, W. (this *Bibliography*, p. 95).

***Groth, M.**

ENAMELS AND GLAZES. See Sommer, F. (this *Bibliography*, p. 283).

Grünwald, J.

CHEMICAL TECHNOLOGY OF ENAMEL RAW MATERIALS. *Glashütte*, **40, 41, 42.**—In 42 installments; more to follow. Article continued to 76 installments. (*Chem. Abs.*, **5**, 2710 (1911); *ibid.*, **6**, 1972 (1912).)

Grünwald, J.

THE TECHNIQUE OF MODERN ENAMELS; ENAMELING OF SHEET-IRON AND CAST-IRON. Book, Published 1910, Paris.

***Grünwald, Julius**

REFERENCE BOOKS ON ENAMELS. *Jour. Amer. Ceram. Soc.* (see this *Bibliography*, p. 166).

Grünwald, Julius

EUROPEAN PRACTICE IN MANUFACTURE OF ENAMELED CAST-IRON WARE. *Jour. Amer. Ceram. Soc.*, **7**, 118 (1924).—Article gives typical mixes of iron as used in Germany, to get castings of the proper composition. A brief description of the preparation of the castings, application of ground and cover coats, is given. G. gives the following composition as the most satisfactory for castings to be enameled: carbon, 3.5%; silicon, 2 to 2.5%; phosphorus, 1 to 1.4%; manganese, 0.5 to 0.7%; and sulphur 0.05 to 0.08% at most. (*Chem. Abs.*, **18**, 1041 (1924).)

Grünwald, Julius

THE TECHNOLOGY OF THE ENAMELING INDUSTRY. *Oesterr. Chem. Ztg.*, **11**, 271; through *Chem. Zentr.*, II, 1644 (1908).—The density of certain enamels is given, with and without water. Certain analytical methods are also given as: For the rapid detection of lead in enamel, wet a small portion of the surface with pure concentrated HNO_3, heat until the acid is evaporated, add several drops of water, and a few drops 10% KI solution. A yellow color is produced by even minute traces of lead. For the rapid determination of Na_2SiF_6, titrate a weighed quantity with 2 *N* NaOH, using phenolphthalein as indicator. Equation: $Na_2SiF_6 + 4NaOH = 6NaF + H_2O + SiO_2$. (*Chem. Abs.*, **3**, 2364 (1909).)

Grünwald, Julius

ENAMELING AND THE FUNCTION OF CLAY IN THE ENAMEL. *Sprechsaal*, **42**, 287 (1909).—It is the function of the clay to hold up the enamel in suspension, to render it more opaque and more elastic after firing as well as to regulate the melting point. The

clay should be as plastic as possible and kaolin should not be used as a rule. It is also advisable to let the clay slip stand for several days. An example of a soft white enamel is given of the composition:

Borax	62 kg.	Saltpeter	3
Tin oxide	5	White clay	2.5
Feldspar	60	Calcined magnesia	0.2
Cryolite	20	Fluorspar	0.1
Calcined soda	4		

After fritting this is ground together with 7 kg. washed white clay, 7 kg. tin oxide, and 300 g. MgO. The fluorine escapes only in part and it is not injurious to the brightness of the enamel. (*Chem. Abs.*, **3**, 1675 (1909); *Chem. and Ind.*, **28**, 600 (1909).)

Grünwald, Julius

CAST-IRON ENAMELS. *Stahl u. Eisen*, **29**, 137 (1909); *Sprechsaal*, **43**, 485 (1910).—Two methods are practiced in cast-iron enameling, the dust method and wet enameling. In the former case a ground enamel is employed; in the latter a ground frit. This frit is prepared by calcining a mixture of basic oxides, borax, silica, and clay to vitrification. The average formula of such a body corresponds to 0.104 PbO, 0.521 Na_2O, 0.156 K_2O, 0.087 CaO, 0.132 MgO, 0.372 Al_2O_3, 10.775 SiO_2, 1.086 B_2O_3, and 0.695 F. The ratio of B_2O_3:SiO_2:alkalis + PbO = 1:9.1:1.2. The PbO may be replaced by borax or alkali. Tin oxide and cryolite must not be used in the ground body. For a covering enamel applied by powdering the formula of Riddle is quoted: 0.40 BaO + PbO, 0.15 K_2O, 0.10 CaO, 0.05 ZnO, 0.25 Na_2O, 0.15 Al_2O_3, 1.0 SiO_2, 0.2 B_2O_3, 0.2 SnO_2. G. recommends a covering enamel of the formula: 0.749 Na_2O, 0.187 K_2O, 0.032 CaO, 0.022 MgO, 0.312 Al_2O_3, 0.905 B_2O_3, 1.279 SiO_2, 0.655 F_2, 0.390 SnO_2. For a covering enamel applied wet as practical in Europe, the following two formulas are given as average compositions, one containing PbO, the other being free from it. (*A*) 0.322 PbO, 0.579 Na_2O, 0.096 MgO, 0.067 Al_2O_3, 0.419 B_2O_3, 2.000 SiO_2, 0.225 F_2, 0.354 SnO_2. (*B*) 0.747 Na_2O, 0.220 K_2O, 0.033 CaO, 0.002 MnO, 0.374 Al_2O_3, 0.68 B_2O_3, 2.00 SiO_2, 0.85 F_2, 0.34 SnO_2. The use of $(NH_4)_2CO_3$ is recommended for white or better class enamels to prevent "parting." CaO and BaO compounds are to be avoided. The use of larger amounts of CaF_2 is not to be recommended. The iron should contain 3.5% C, 2% Si, 0.5 to 0.7% Mn. Tin oxide and cryolite are the best opacifiers. (*Chem. Abs.*, **5**, 168 (1911).)

Grünwald, J.

STIFFENING OF WET GROUND ENAMELS. *Sprechsaal*, **43**, 594 (1910).—The reagents recommended are ammonium chloride or carbonate, magnesium oxide, and borax. These reagents act principally upon clay, the presence of which is indispensable. Excess of reagent prevents the desired effect. Na_2SiO_3 at first makes the suspension more fluid, then stiffens it. Neither soda nor acids are recommended for use in this connection. (*Chem. Abs.*, **5**, 168 (1911); *Chem. and Ind.*, **29**, 1251 (1910).)

Grünwald, J.

USE OF ZIRCONIA IN THE ENAMELED IRON INDUSTRY. *Sprechsaal*, **44**, 72 (1911).—Doubt is expressed as to the efficiency of zirconium oxide as an opacifier. The satisfactory effect found by Hartmann is due to the high content, 14% of ZrO_2 and of cryolite, 21%. The batch composition of Hartmann is quoted as being 37.5% feldspar, 18% borax, 21% cryolite, 10.5% quartz, 0.7% KNO_3, 8% ZrO_2 in the frit, 6% ZrO_2 in the mill, 7% clay in the mill. (*Chem. Abs.*, **5**, 2163 (1911); *Chem. and Ind.*, **30**, 210 (1911).)

Grünwald, Julius

ANNEALING AND PICKLING OF THE FINISHED IRON ARTICLES BEFORE ENAMELING. *Stahl u. Eisen*, **29**, 137 (1909).—Iron to be drawn or pressed should have this composition:

C 0.05 to 0.08, P less than 0.03, Mn 0.25 to 0.35, Si 0.02. Cast iron should have the composition: C 3.5, Si 2.0, P 1.4 to 1.8, Mn 0.5 to 0.7. In annealing, a temperature between 750 and 850° is desirable. Air should be rigidly excluded and cooling should be very slow. Space should be left between the different pieces. The heating must be uniform and if a pointed flame is used, the pieces should be turned around continuously. For pickling HCl is the best, though H_2SO_4 is often used. Either acid should be free from arsenic to avoid poisoning the workmen. The piece should be immersed 30 to 45 minutes in a bath heated to 20 to 30°C. The article should be immediately dipped in a soda bath and then washed and dried quickly. The object of the pickling is not only to clean the surface but also to prepare the surface so it can get a better hold on the enamel. Pickling seems to embrittle the metal; this brittleness, however, disappears on heating to over 130°, a temperature attained in the drying hearth in most plants. (*Chem. Abs.*, **3**, 878 (1909); *Chem. and Ind.*, **28**, 204 (1909).)

Grünwald, J.

CAST-IRON ENAMELS. *Stahl u. Eisen*, **30**, 1201 (1910).—A review of the enamel industry is given and the composition of enamels for cast iron is discussed, with special reference to the expansion and liability to crack of lead enamels. The use of appreciable amounts of baryta and lime, or large amounts of fluorspar is not to be recommended, while the proper firing in the muffle in the absence of deoxidizing gases is essential. A reliable product is only obtained by the use in the frit of the best tin oxide and natural cryolite. Enamels containing lead are very deceptive as to their brilliancy and fusibility, and the lead can be completely replaced by borax. The following are types of such replacing enamels:

$$\left.\begin{matrix}0.322\ PbO\\0.579\ Na_2O\\0.096\ MgO\end{matrix}\right\}\ 0.067\ Al_2O_3\ \left\{\begin{matrix}0.419\ B_2O_3 & 0.747\ Na_2O\\2.000\ SiO_2 & 0.220\ K_2O\\0.225\ F_2 & 0.033\ CaO\\0.354\ SnO_2 & 0.002\ MnO\end{matrix}\right\}\ 0.374\ Al_2O_3\ \left\{\begin{matrix}0.68\ B_2O_3\\2.00\ SiO_2\\0.85\ F_2\\0.34\ SnO_2\end{matrix}\right.$$

The lead oxide should not exceed 25%, and the addition of ammonium carbonate is strongly recommended to produce a good surface. A useful cast iron is one containing 3.5% of carbon, 2.0 of silicon, 1.5 of phosphorus, and 0.6 of manganese. (*Chem. and Ind.*, **29**, 951 (1910).)

***Gummert, H.**

PHOSPHIDE EUTECTIC IN CAST IRON. See Jungbluth, H. (this *Bibliography*, p. 167).

Gumz, J. H.

GAS IN THE ENAMELING INDUSTRY. *Gas. Rec.*, Dec. 22, 1920.—Vitreous enamels are differentiated from japan varnishes and a historical sketch of the industry is given together with a brief description of the enameling process. G. emphasizes the necessity of a muffle-type furnace with coal as fuel, or even with gas or oil when the surface combustion or intermittent firing plan is not used. Cross-section views of the various types of furnaces are shown. The muffle-type furnace especially where coal is the fuel, shows highest construction and repair costs and requires the most floor space. Firing costs of the various types of furnaces per cu. ft. of oven space heated per hour are as follows:

Type of furnace	Without recuperation	With recuperation
Direct-fired gas	1.0 cent	0.8 cent
Semimuffle gas	1.4	1.1
Oil-fired (prob. muffle)	1.5	1.2
Full-muffle gas	1.6	1.2
Coal-fired muffle	1.7	1.3
Electric direct	...	1.4

Further savings results from applying flue gases in waste heat boilers and dry rooms. Some of the advantages claimed for the direct-fired gas furnace are: (1) lower operating cost, (2) lower construction cost (no stacks, muffles, etc.), (3) low repair cost, (4) elimination of coal and oil storage and fireman, (5) uniform heating and a larger percentage of furnace available for firing ware, (6) absolute control and ability to change temperature rapidly as required, and (7) increased output. (*Chem. Abs.*, **15,** 739 (1921); *Jour. Amer. Ceram. Soc.* (Abs.), **4,** 254 (1921).)

***Gumz, J. H.**

ENAMELING FURNACE. See Mackey, F. C. (this *Bibliography*, p. 203).

Guntz, A. A.

PHOSPHORESCENT SULPHIDES AND THEIR APPLICATION. *Chim. et Ind.*, **4,** 597 (1920).—A general review of the history of the phosphorescent sulphides, the theories advanced to explain their action, their principal properties, and the various industrial applications to which they have been put including those depending on the action of ultra-violet light, X-rays, Ra, and other radioactive substances and light. (*Jour. Amer. Ceram. Soc.* (Abs.), **4,** 516 (1921).)

Gurney, H. P.

MODULUS OF HARDNESS OF VULCANIZED RUBBER. *Ind. Eng. Chem.*, **13,** 707 (1921).—The modulus of hardness of rubber is the ratio of the force applied to produce a depression to the volume of the depression produced. It may be most satisfactorily ascertained by use of an instrument of the dead-weight type, such as the plastometer. As the instrument is generally employed, the dial reading is taken after a load of 1000 grams has been acting for 60 seconds to depress into the rubber sample a point consisting of a steel ball, 0.125 inch diameter. If d is the extent to which the point is depressed (1 dial division = a depression of 0.01 mm.) and R the radius of the ball, the volume of the depression is $\pi d^2 (R - d/3)$. The apparent hardness in dynes per cc. can be estimated approximately by dividing 2.75×10^{12} by the plastometer reading. Data referring to two samples, of plastometer readings 110 and 40, respectively, show that the relation between force and volume depression is almost linear (and hence the modulus is almost constant), except in the vicinity of the origin, for forces up to 1,000,000 dynes. Data are given showing the influence on the figure for hardness of (*a*) the time for which the force acts, (*b*) the temperature, (*c*) the thickness of the slab. The rate at which the plastometer reading increases with time is not the same with all rubber samples. Stocks of a hardness of 5×10^8 dynes per cc. tend to be at least affected in hardness by temperature changes. As the thickness of the slabs tested increases, the hardness asymptotically approaches a limit, in the samples shown, at a thickness somewhat greater than 1 cm. In general, hardness increases with (*a*) increase in the S/rubber ratio, (*b*) decrease in the rubber content, (*c*) increase in the vulcanization period. Some graphs relative to these conclusions are shown. (The data given concerning the composition of the compounds to which the graphs refer are incomplete.[1]) The practical application of the hardness constant to the design of rubber-covered rolls is discussed. (*Chem. Abs.*, **15,** 3768 (1921).)

Guthrie and Co.

ANTICORROSIVE CHEMICAL ENGINEERING PLANT (PUMPS FOR CORROSIVE LIQUIDS). *Can. Chem. Met.*, **5,** 341 (1921); *Engineering*, **110,** 253 (1921).—Describes centrifugal pumps and other equipment lined with a new ceramic acid and heat coating, called ceratherm, which resembles porcelain. The ceramic lining is cast in the desired form

[1] Abstractor.

and cemented into place with an acid-proof cement. It is a good heat conductor, resists sudden temperature changes, has high tensile strength, and is claimed to be superior to all other ceramic coatings hitherto employed. (*Ceram. Abs.*, **1**, 83, 117 (1922).)

Haber, F.

ZIRCONIUM OXIDE REPLACES STANNIC OXIDE IN ENAMEL INDUSTRY. *Ind. Eng. Chem.*, **6**, 326 (1914).—The naturally occurring zirconium silicate is treated by alkali and a product of about the following composition is obtained: ZrO_2 83%, TiO_2 4%, SiO_2 9%, Na_2O 2%, the remainder being water. This impure zirconium oxide is replacing stannic acid. It is used in the same quantities and in the same way.

Hackney

USE OF BORATE OF CALCIUM IN GLAZES. *Rep. of p.e.s.*, **27**, p. 53; *Mon. ind.*, No. 2120 (1857). (*Rep. der Tech. Lit.*, p. 306 (1854–1868).)

Hadfield, R.

SHEFFIELD AND METALLURGICAL DEVELOPMENT. *Engineering*, **122**, 43 (1926).—An address delivered at the opening of the new Eng. and Met. Labs. at Sheffield University, July 2, 1926. Owing to Sorby, Sheffield was the birthplace of the science of metallography; H.'s manganese steel made it the home of modern steel alloys; and the American Holley, owed to Sheffield his training in the Bessemer process. Other important advances of the past fifty years have been the perfecting of chemical analysis, the precise measurement of high temperatures and of the effects of thermal treatment on the molecular structure of iron and steel, and the improvement and general adoption of electric steel-melting furnaces. (*Ceram. Abs.*, **6**, 9 (1927).)

Haen, E. de

ENAMELS AND GLAZES. Chem. Fabrik List G.m.b.H. German Pat. 289,317, Jan. 14, 1913.—Zinc sulphide is used as a substitute for the oxide as a clouding agent for enamels and glazes. Small amounts of zinc sulphide are sufficient to impart complete opacity to the enamel. Even when the melt is transparent, 5% of the sulphide will be sufficient. The sulphide is mixed as a powder with the powdered glaze material. Colors or oxides may be mixed with the mass. (*Chem. Abs.*, **10**, 2792 (1916).)

Hahn, C. A.

CONSTRUCTION AND OPERATION FEATURES OF THE RO-MACK ENAMEL FURNACE. *Ceram. Ind.*, **1**, 88 (1923).—The furnace itself rests on a concrete pier and is built with standard shape fire brick. It is intermittent open oil fire type and gives a positive controllable furnace condition. It is of solid construction, checker work, muffles, recuperators, and so forth, being eliminated. The firing is done in the firing chamber while the load is out. When the door is opened the in-rush of oxygen oxidizes and sweeps detrimental gases up the stack. The salient features of this furnace are: (1) absolute control of temperature, (2) low operating charge, (3) absence of repairs accompanied by subsequent shut downs, (4) increased production, (5) accessibility to all parts for repairs, and (6) standardized equipment.

Hahn, C. A.

KILN FOR ENAMELING WARE. U. S. Pat. 1,549,830, Aug. 18, 1925.—An enameling apparatus comprising a front, a rear, and two side walls, a baking chamber located within side walls, a floor for baking chamber, passage ways located beneath floor and communicating with baking chamber, a regenerating chamber in communication with passage ways, air coils located in regenerating chamber, a valve for controlling the ad-

mission of air to coils, and means for projecting a heating medium into baking chamber. (*Chem. Abs.*, **19**, 3576 (1925).)

Hall, F. P.

PLASTICITY OF CLAYS. *Jour. Amer. Ceram. Soc.*, **5**, 346 (1922).—Discussion of the term "plasticity" and the methods brought forward for the measurement of plasticity; the factors which each measures; the use of the Bingham plastometer as an instrument for determining relative plasticity of clays; the need for more efficient methods of measuring plasticity. Factors to be considered in measuring plasticity are (1) resistance which a clay offers to changing its shape, and (2) the amount of deformation which a clay can suffer without cracking. Mellor suggests the following formula as a definition of plasticity:

$$\text{Plasticity} = \frac{\text{Cohesion}}{\text{Internal friction}}$$

Cohesion may be taken as (2) above and internal friction as (1). The methods of measuring plasticity are: (1) *Dye absorption test:* Ashley assumes that plasticity of clay was inversely proportional to the grain size, hence the clay having the highest colloidal content was the most plastic. The colloidal content was measured by dye absorption. This method is not correct because the colloids in different clays would have different powers of absorption. (2) *Method of G. E. Stringer and W. Emery:* They measure the relations between the proportion of water, the resistance to changing shape, and deformation the clay can suffer without cracking. (Method is described.) Concordant results are difficult to obtain by this method. (3) *MacMichael torsional viscosimeter:* Results obtained by this method are not reproducible, due to what may be called a "puddling effect." (4) *Emley plasticimeter:* The plasticimeter measures the property of retaining water and the resistance to deformation under pressure that a substance possesses. (5) *Atterberg plasticity method:* The range of water content over the workable stage is determined. One arbitrary limit of the workable stage is the point when the clay mass will barely flow, while the other limit is the point when the clay mass can no longer be rolled into threads. It is Atterberg's contention that the wider this range the more plastic the clay. It is evident that in a method of this type too much is left to the judgment of the person conducting the tests. (6) *Bingham plastometer:* The rate of flow through a capillary tube under a definite constant pressure head is determined. The flow at several pressures having been determined, the volume discharge per second is plotted against the pressure producing the flow. For plastic substances the relation is linear at high pressures but if this linear portion of the curve is extended to the pressure axis it will not intersect the axis at zero but at a finite point on the pressure axis. The intercept of this curve on the pressure axis is determined by the initial friction value of the plastic material. This value is also designated as the yield value. The slope of this curve is determined by the mobility of the plastic material. These two factors, mobility and yield value, define roughly the plasticity of a substance. This conception of plasticity seems to be a better definition than that commonly given by ceramists. (*Chem. Abs.*, **16**, 2762 (1922).)

Hall, F. P.

EFFECT OF HYDROGEN-ION CONCENTRATION ON CLAY SUSPENSIONS. *Jour. Amer. Ceram. Soc.*, **6**, 989 (1923).—This paper includes a preliminary report on the study of clay suspensions. Two methods commonly used for measuring the hydrogen- and hydroxyl-ion concentrations of aqueous solutions are outlined. The hydrogen-ion concentration of the water extract from several clays is given. The effect of the hydrogen-ion concentration of the suspending medium on the rate of settling of suspended

clay is given for several different clays. The action of alkali on suspended clay is studied. The hydrogen-ion value of the water extract from several clays varied from 3 to 8.5. The hydrogen ion at the isoelectric point (point showing maximum rate of settling) on 6 samples varied from 3.8 to 5.80. The hydrogen ion at the point of maximum deflocculation on the same six samples varied from 10.32 to 12.01.

***Hall, F. P.**

MEASUREMENT OF THE PLASTICITY OF CLAY SLIPS. See Wilson, R. E. (this *Bibliography*, p. 337).

Hanna, H. H.

THE MOST FUSIBLE MIXTURES OF K_2O–CaO–Al_2O_3–SiO_2. *Trans. Amer. Ceram. Soc.*, **17**, 672 (1915).—The following raw materials were used: commercial feldspars, kaolin, and flint (analyses are given). *Kaolin-feldspar:* Mixtures with 0 to 20% kaolin were made into cones and fused. Results were not entirely clear but the eutectic was very close to 8% kaolin, 92% feldspar. *Feldspar-ball clay:* This same per cent eutectic was found at 8% ball clay, 92% feldspar. *Feldspar-quartz:* There was a eutectic at 4% quartz. Rankin and Wright (cf. *Chem. Abs.*, **9**, 702) gave 1165° as the melting-point eutectic between pseudo-wollastonite, anorthite, and tridymite, the composition being 25.25 CaO, 14.75 Al_2O_3, 62 SiO_2. Deformation point of cones with ranges and composition covering this point showed this to be the deformation eutectic, as well as the actual melting-point eutectic. Expressed in molecular form this eutectic is 1.00CaO, 0.348 Al_2O_3, 2.489 SiO_2. Trials were then made with all mixtures of the 3 eutectics: (1) 96% feldspar, 4% quartz; (2) 23.5 CaO, 14.75 Al_2O_3, 62.0 SiO_2; (3) 92% feldspar, 8% kaolin. The first to deform was 0.6 K_2O, 0.4 CaO, 0.739 Al_2O_3, 4.829 SiO_2. The next to deform was: 0.6 K_2O, 0.4 CaO, 0.777 Al_2O_3, 4.830 SiO_2. The third to deform was: 0.6 K_2O, 0.4 CaO, 0.8114 Al_2O_3, 4.824 SiO_2. The only difference in these 3 compositions is in Al_2O_3. The lowest fusing point mixture of K_2O, CaO, Al_2O_3, and SiO_2 is: 0.60 K_2O, 0.40 CaO, 0.739 Al_2O_3, 4.829 SiO_2 which starts to deform with Seger cone 3 but is completely deformed when cone 3 is only three-fourths down. (*Chem. Abs.*, **10**, 680 (1916).)

Hansen, J. E.

TECHNIQUE OF VITREOUS ENAMELING CAST IRON BY THE WET-PROCESS, SHEET IRON. Ferro Enamel Supply Company, Publisher, 1927.—The following subjects are discussed in the various chapters: (1) Selection and fabrication of the base metal for enameling. (2) Preparation of metal surfaces. (3) Enamel mill room practices. (4) Mill additions, colors, and color matching. (5) Application of the enamel. (6) The drying and brushing of enamel. (7) Firing. (8) Inspection. (9) Graining, stencils, and decalcomanias. (10) Notes on shop troubles. (11) Enamel shop management.

Hansen, J. E.

WELL-INSULATED DOORS BOOST FURNACE PRODUCTION. *Ceram. Ind.*, **4**, 112 (1925).—(Answer to questionnaire on "Enamel Furnace Design.") Attention is called to the amount of ware fired in the various furnaces. There is an average utilization of 60% of the floor area in the furnace by ware being fired, with a high figure of 78% and a low figure of 35.6%. The point for improvement to be suggested is in having a well-insulated furnace door to prevent as much loss of heat as possible, and a furnace so designed as to flues and heat distribution that there will be no hot and cold spots, with the result that the furnace may be worked to nearer the complete area of the firing chamber. (*Ceram. Abs.*, **4**, 126 (1925).)

Hansen, J. E.

FISHSCALING OF SHEET-IRON ENAMELS. *Ceram. Ind.*, **6**, 40 (1926).—Fishscaling appears under so many different circumstances that probably there is not any one cause, but there may be many causes of it. Chief among the causes which have been advanced are: (1) composition of the enamel, (2) improper smelting, (3) improper milling, (4) character of clay used, (5) character of iron, (6) improper pickling of the iron, (7) underfiring, (8) overfiring, (9) type of furnace used, and (10) leaking of muffle furnaces. The addition of 5 to 10% raw quartz at the mill, besides the regular mill additions to the ground coat, using a proportionately increased amount of water, will eliminate most of the fishscaling unless the conditions under which the enamel is applied are radically wrong. For discussion see this *Bibliography*, p. 57.

Hansen, J. E.

FIRING OF WET-PROCESS CAST-IRON ENAMELS. *Enamelist*, **5** [1], 7 (1927).—The firing temperature will vary with the nature of the enamel formula. The firing time depends upon enamel composition, thickness of enamel coating, size of castings, weight of load, and the furnace itself. The "comeback" of the furnace is the time required for the furnace to return to the finish firing temperature after introduction of a load of ware.

Hansen, J. E.

NOTES ON SHOP TROUBLES. *Enamelist*, **5** [3], 7 (1927).—Chapter reprinted from "The Technique of Vitreous Enameling by the Wet Process on Cast Iron and Sheet Steel."

Hansen, J. E.

TYPES OF ENAMEL SMELTERS. *Fuels and Fur.*, **2**, 141 (1924).—Rapid even heating is required in the successful manufacture of enamel frit. The older furnaces are of the stationary reverberatory type, fired either with coal, gas, or oil, but recently the rotary furnace, fired either with gas or oil, has come into use. The advantages of the rotary type are: (1) the melted enamel is free from any danger of overfiring, for it is being constantly kept at the fusing point of the charge, and (2) the unmelted enamel is exposed to the heat and, layer by layer, rolls or curls into the bath, reducing the melting time and fuel consumption. (*Ceram. Abs.*, **4**, 62 (1925); *Chem. Abs.*, **18**, 2589 (1924).)

Hansen, J. E.

MODIFICATION OF THE EMPIRICAL FORMULA IN GLAZE AND ENAMEL CALCULATIONS. *Jour. Amer. Ceram. Soc.*, **5**, 338 (1922).—The short-comings, disadvantages, and objections to the usual type of molecular formula are reviewed, and it is shown by calculation back to the batch mixture how the molecular formula may be misinterpreted. A new type of molecular formula is proposed as follows:

$$\left.\begin{matrix} Na_2O \\ Na_2F_2 \\ K_2O \\ CaO \\ CaF_2 \\ BaO \\ ZnO \\ PbO \end{matrix}\right\} \quad \begin{matrix} \\ \\ \\ Al_2O_3 \\ Al_2F_6 \\ \\ \\ \end{matrix} \quad \left\{\begin{matrix} SiO_2 \\ SiF_4 \\ B_2O_3 \\ Sb_2O_3 \end{matrix}\right.$$

The advantages of this new type of formula are that (1) It presents data in the usual simple and graphic manner. (2) It indicates the mineralogical and physical condition in which most of the important constituents are introduced into the batch. (3) It admits of but little danger of obtaining the wrong batch mixture upon calculation back

to the raw materials. (4) The conclusions to be drawn from it are quite fixed and definite. For discussion of this paper see *Bull. Amer. Ceram. Soc.*, **1**, 235 (1922) by H. F. Staley, R. R. Danielson, and R. D. Landrum. Also see this *Bibliography*, p. 38. (*Chem. Abs.*, **16**, 2763 (1922); *Chem. and Ind.*, **41A**, 634 (1922).)

Hansen, J. E.

EXACT NOTIONS OF FLUORINE ENAMELS. (Discussion.) *Jour. Amer. Ceram. Soc.*, **7**, 115 (1924).—H. believes that Musiol should substantiate his conclusions with chemical data, showing either the absence of silicon tetrafluoride in the by-product gases, or the presence of definite fluorine compounds of different nature, rather than by basing his conclusions on a mathematical proof, in which there is the possibility of a fallacy. H., as do Mayer and Havas and Musiol, admits the great probability that the fluorine may have been driven off in combination with boron, as boron fluoride. Reply to this discussion by Musiol, *Bull. Amer. Ceram. Soc.*, **3**, 224 (1924). (See this *Bibliography*, pp. 41 and 221.)

Hansen, J. E.

EFFECT OF MILL PRACTICE ON WORKING PROPERTIES AND FINISH OF VITREOUS ENAMELS. *Jour. Amer. Ceram. Soc.*, **10**, 517 (1927).—Variations in mill or grinding practice are shown to affect the working properties and finish of vitreous enamels. Uniform mill practice from day to day is necessary for exact color matches in some shades of enamels. Too small a mill charge contaminates the enamel with abraded pebble and mill-lining material, and may, therefore, decrease the gloss and alter the color. Attention is called to the possibility of obtaining too much "set-up" in an enamel charge ground in a new or newly relined pebble mill. The particle fineness of the enamel may be tested by the usual screen test, or in a cone screen, which is described. (*Ceram. Abs.*, **6**, 327 (1927); *Chem. Abs.*, **21**, 3438 (1927); *Enamelist*, **5** [2], 10 (1927).)

Hansen, J. E.

MODIFICATION OF THE MOLECULAR FORMULA FOR GLAZE AND ENAMEL CALCULATIONS. (Discussion.) *Bull. Amer. Ceram. Soc.*, **1**, 235 (1922). (See *Bull. Amer. Ceram. Soc.*, this *Bibliography*, p. 38); WET-PROCESS ENAMELS FOR CAST IRON. (Discussion.) (See *Bull. Amer. Ceram. Soc.* this *Bibliography*, p. 38); EXACT NOTIONS OF FLUORINE ENAMELS. (Discussion.) (See Musiol, C., this *Bibliography*, pp. 42 and 221.)

Hansen, J. E., and Lindsey, Gordon S.

HAIRLINES IN SHEET-IRON ENAMELS. *Jour. Amer. Ceram Soc.*, **8**, 356 (1925).—Hairlines in sheet-iron enamels may be caused either by underfiring of the ground coat enamel, or by "cold spots" on the ware when the cover enamel is fired. The defect may be prevented by properly firing the ground-coat enamel, and by proper arrangement of the ware on the firing supports in the furnace. These trials show that there are at least two conditions under which hairlines will appear in enamels, *i.e.*, from an underfired ground coat enamel, and from "cold spots" caused by contact with, or close proximity of the enameled ware to cold objects as it is fired in the furnace. The underfired ground coat may be the result of too short a firing time, too low a firing temperature, or of too thick enamel, in which case the problem resolves itself into properly setting up the enamel before dipping and firing. The remedies to be suggested are quite obvious. Proper firing of the ground coat will eliminate much of the hairlining from the underfiring factor. This may entail firing smaller loads of ware, to insure that it is all properly fired. In the case of ware having rolled edges, or double thicknesses of metal which absorb heat more slowly than other sections, it might be advisable to remove the ware from the furnace for a few seconds after it has reached red heat and allow the thin sec-

tions to cool, and then run it back into the furnace until the ground coat is fully matured. Likewise, firing the ground coat at a slightly lower temperature than usual for a somewhat longer time would allow the heavier parts of the ware to become properly fired without danger of badly overfiring the remainder of the ware. The elimination of cold-firing supports, or placing the ware in a different manner in the enameling furnace, should eliminate hairlining due to unequal heating in the finish coats of enamel. (*Enamelist*, **2** [5], 10 (1925); *Chem. Abs.*, **19**, 3154 (1925); *Chem. and Ind.*, **44B**, 591 (1925).)

Hansen, J. E., and Lindsey, G. S.

FACTORS INFLUENCING THE RATE OF PICKLING OF SHEET IRON. *Jour. Amer. Ceram. Soc.*, **9**, 481 (1926).—Experiments with regard to various factors entering into pickling show that: (1) A freshly made sulphuric acid pickling bath pickles faster than a bath in which there is any concentration of ferrous sulphate. (2) There is no evident advantage in adding a portion of old pickling solution to a new pickling solution "to get it to work right," although practical experience indicates otherwise. (3) Increased ferrous chloride concentration in a muriatic acid pickling bath increases the rate of pickling. (4) Ferric sulphate in a sulphuric acid bath will accelerate the rate of pickling, but will soon change to ferrous sulphate and then retard the rate. (5) Decrease in acidity from usual strength decreases rate of pickling. (6) Increase of temperature of bath accelerates rate of pickling. (7) Iron annealed just previous to pickling loses 250 to 400% more in pickling than unannealed iron. (8) Use of Monel metal baskets accelerates the rate of pickling due to electrochemical reactions. (9) Use of muriatic acid or sodium chloride in mixtures with sulphuric acid retards the rate of pickling. (*Ceram. Abs.*, **5**, 298 (1926).)

Hansen, R. T.

RED CUPRIFEROUS PIGMENT FOR IRON ENAMEL. Danish Pat. 30,646, Nov. 13, 1922.—A mixture of copper sulphate solution, tin-putty, and gum arabic with a diminutive addition of gold chloride or cinnabar. (*Ceram. Abs.*, **3**, 96 (1924); *Chem. Abs.*, **18**, 453 (1924).)

Harkout, H.

PREPARING FRIT FOR GLAZES AND ENAMEL FREE FROM LEAD AND BORON. German Pat. 342,405, Dec. 8, 1917.—In the first mixing more alumina than can be taken up is used. The mixture is then ground mechanically as finely as possible and again fritted after, if desired, addition of basic substances. (*Chem. and Ind.*, **41A**, 103 (1922).)

Harol J., Vol. 12, p. 20.

ON ENAMELS. (*Rep. der Tech. Lit.*, p. 405 (1869–1873).)

Harper, John L.

ELECTRICITY FOR FIRING CERAMIC WARE AND FOR ITS ENAMELING. *Céramique*, **16**, 64 (1913).—Description of an electrically heated kiln, claimed to produce a uniform heating of the ware to a high temperature (1650°) with the minimum consumption of energy. Coal, oil, or gas can be used to fire this kiln. (*Chem. Abs.*, **7**, 2102 (1913).)

Harrison, A. C.

PRELIMINARY STUDY OF RESISTANCE TO ABRASION OF CERAMIC GLAZES, ITS CONTROL AND METHODS OF DETERMINATION. *Jour. Amer. Ceram. Soc.*, **10**, 77 (1927).—Two test methods, one using an Ingersoll glarimeter to obtain results of a high degree of accuracy, and the other simpler "alternate method" for plant control, are described in detail. Tests on commercial hotel chinaware showed the average resistance of

foreign ware was higher than that of the domestic and the variation from the average was, in general, less. Experimental glazes were prepared to study the effect on resistance of: (1) varying SiO_2 and Al_2O_3 content, (2) glaze thickness, and (3) firing treatments. Data obtained are insufficient to justify definite conclusions regarding the effect of varying SiO_2 and Al_2O_3 but do show the resistance of well-matured glazes to be inversely proportional to thickness, a decrease in resistance as the tendency to mat increases, a markedly increased resistance by the higher glost fire. That type of body affects resistance less than do glaze composition and temperature of glost fire. (*Ceram. Abs.*, **6**, 151 (1927); *Chem. Abs.*, **21**, 1172 (1927); *Chem. and Ind.*, **46B**, 749 (1927).)

Harrison, W. N.

VITREOUS ENAMEL SLIPS AND THEIR CONTROL. *Jour. Amer. Ceram. Soc.*, **10**, 970 (1927).—The purpose of this work was to study vitreous enamel slips in order to develop adequate means for measuring and controlling their consistency under plant conditions. A suitable laboratory means for determining their consistency was first selected, and the effect of various factors upon consistency determined by this means. In order to learn something of the mechanism by which changes in consistency take place, observations were made upon the physico-chemical nature of the different phases of several typical slips, also the state of flocculation of the finer particles of suspended matter was observed under different conditions known to produce slips of different consistencies. A simplified method of determining consistency, suitable for plant use, was then devised, and the work carried into the field. This simplified means was put into use in conjunction with other tests, in order to obtain data for correlating consistency as determined by this method with the working properties of the slips.

***Harrison, W. N.**

DEVELOPMENT OF SOME JEWELRY ENAMELS. See Wolfram, H. G. (this *Bibliography*, p. 340).

FACTORS AFFECTING WARPAGE OF SHEET IRON AND STEEL IN ENAMELING. See Danielson, R. R. (this *Bibliography*, p. 86).

EFFECTS OF COMPOSITION ON PROPERTIES OF SHEET-STEEL ENAMELS. See Wolfram, H. G. (this *Bibliography*, p. 340).

Harrison, W. N., and Hartshorn, T. D.

PRELIMINARY STUDY OF CERAMIC COLORS AND THEIR USE IN VITREOUS ENAMELS. *Jour. Amer. Ceram. Soc.*, **10**, 747 (1927).—This report deals with the results obtained from a study of ceramic colors as used in vitreous enamels. Numerous coloring stains were produced and used in various enamel compositions. The batch formulas of the stains are given, and methods of preparation described. To obtain uniformity of texture of the colored enamels and to insure accuracy of duplication in preparing successful batches of a given stain, it was found desirable (*a*) to duplicate accurately time and temperature of calcination, and in some cases, furnace atmosphere; (*b*) to wash the stains free from soluble matter after calcination; (*c*) to grind and pass them through a fine screen before use; and (*d*) to keep the enamel composition constant. Several of the stains were produced on a relatively large scale and tested commercially under plant conditions. These gave excellent results. (*Ceram. Abs.*, **6**, 503 (1927); *Chem. Abs.*, **21**, 4039 (1927).)

Harrison, W. N., and Wolfram, H. G.

EFFECTS OF COMPOSITION ON THE PROPERTIES OF GROUND-COAT ENAMELS FOR SHEET STEEL. *Jour. Amer. Ceram. Soc.*, **10**, 163 (1927).—A series of ground coats was developed about each of three refractory bases, one of which consisted of flint and feldspar in a ratio frequently used commercially, another consisting of feldspar only, and

the third of flint only. In each case the refractory portion was 58.5 parts of the whole. Besides the refractory, a "fixed addition" of 11.5 parts, comprised of 0.5 cobalt oxide, 1.0 manganese oxide, 5.0 boric oxide, and 5.0 sodium oxide, was used in every enamel, bringing the basic constant portion for each series to 70 parts of the whole. The variable portion in each series was made up of equal parts of three constituents commonly used in enameling, chosen from a total of six in such a way that every possible combination was employed, making a total of twenty enamels in each series. All were given two cover coats of a standard white and tested for resistance to mechanical and thermal shock. In general, the ingredients which were most conducive to resistance to the test treatments were flint in the refractory portion, and sodium oxide in the variable portion, constituted of fluxes. Boric oxide also favorably influenced resistance to mechanical shock in the series containing both flint and feldspar. Resistance to mechanical and thermal shock in ground coats was considerably less affected by variations in expansivity than in the case in cover coats, the influence of that factor appearing to be partially obscured by other factors. (*Chem. Abs.*, **21**, 1875 (1927); *Chem. and Ind.*, **46B**, 779 (1927); *Ceram. Abs.*, **6**, 168 (1927).)

Hartman, John

FISHSCALING OF SHEET-IRON ENAMELS. *Ceram. Ind.*, **6**, 43 (1926).—A softer grade of metal base will eliminate fishscale. Trouble may also be eliminated by careful pickling, firing, and the use of a combination of clays. For discussion see this *Bibliography*, p. 57.

Hartmann, A.

ZIRCON ENAMEL. *Z. anorg. Chem.*, pp. 178-227 (1909); *Keram. Rundschau*, **19**, 118 (1911).—The B_2O_3 of enamels seems to reduce their capacity to take up ZrO_2. In the presence of PbO as much as 20% ZrO_2 may be taken up in clear fusion. Upon substituting 5 to 10% SnO_2 in the usual enamels by the same amounts of ZrO_2 the covering power of the enamel is decreased. More of the latter is therefore required to accomplish the same purpose. Zirconium borate was found to be an excellent opacifier in which case the B_2O_3 of the enamel must be decreased correspondingly. The use of fritted ZrO_2 increases the acid resistance of the enamel. The function of the ground coat is supposed to be the protection of the tin oxide from reduction by iron. The use of a less easily reducible opacifier might do away with the necessity of a ground coat. The use of ZrO_2 enamels might have some influence in this direction since it, as well as its borate, is very resistant to reducing influences. (*Chem. Abs.*, **5**, 1981 (1911).)

***Hartshorn, T. D.**

FACTORS AFFECTING THE WARPAGE OF SHEET IRON AND STEEL IN ENAMELING. See Danielson, R. R. (this *Bibliography*, p. 86).

PRELIMINARY STUDY OF CERAMIC COLORS AND THEIR USE IN VITREOUS ENAMELS. See Harrison, W. N. (this *Bibliography*, p. 147).

Haschek, K.

DECORATING ENAMELED METAL PRODUCTS. German Pat. 275,560, Dec. 28, 1912.—Applying to the enameled articles a white or colored glazing composed of a mixture of white glaze (alkali-lime-aluminum-silicate-borate with SnO_2 as opaquing agent) and $MgCl_2$, starch and glaze rich in SiO_2, then stippling this coating, while in a moist state, with pad-, brush-, or sponge-devices, and finally drying and firing. (*Chem. Abs.*, **9**, 852 (1915).)

***Hatschek, E.**

THE VISCOSITY OF SUSPENSIONS OF RIGID PARTICLES AT DIFFERENT RATES OF SHEAR. See Humphrey, E. (this *Bibliography*, p. 158).

Haupt, H., and Popp, G.

USE OF OPACIFIERS CONTAINING ANTIMONY IN THE ENAMEL INDUSTRY. *Z. angew. Chem.*, **40**, 218 (1927).—A German opacifier "Leukonin" and an English "Timonox" are compared for their content of Sb_2O_3 and Sb_2O_5 solution in 1 to 3% tartaric acid, 3% KOH, 4% acetic acid, water, and apple and sauerkraut juices. The Timonox shows much the higher solubility especially in its content of Sb_2O_3. Since Sb_2O_3 is more toxic than Sb_2O_5, Timonox is considered unsafe for use in enamel for cooking ware. Leukonin is safe to use. (*Ceram. Abs.*, **6**, 327 (1927); *Chem. Abs.*, **21**, 1875 (1927); *Chem. and Ind.*, **46B**, 411 (1927).)

Havas, B.

SHEET-IRON ENAMELS. Book: Published 1910. F. Gutsch, Karlsruhe.—Working method of enameling industry, coefficients of expansion of enamel composition and clouding.

Havas, B.

MANUFACTURE OF ZIRCONIUM OXIDE. German Pat. 262,009, May 5, 1913.—In the manufacture of zirconium oxide free from iron, of value in the enamel industry, a weak hydrochloric acid solution of a zirconium salt is heated in a closed vessel to temperatures above the boiling point of the solution at the ordinary pressure, whereby zirconium oxyhydroxide separates and is freed from the supernatant liquid by filtration, centrifugation, and washing. After ignition, a snow-white product is obtained. Other acids may be used as well as hydrochloric, *e.g.*, a 9% solution of zirconium hydroxide in hydrochloric acid, containing about 5% of the weight of the hydroxide as iron or alkaline earth chloride, is heated in a pressure vessel for 5 hours at 200°. Further details are specified. (*Chem. Abs.*, **7**, 3650 (1913).)

Havas, B.

FUNCTION OF THE GROUND ENAMEL. *Sprechsaal*, **44**, 72 (1911).—(Reply to Tostman; see this *Bibliography*, p. 311.) The cobalt silicate of the ground enamel is reduced to a lower stage of oxidation as it is not likely that the cobalt oxide is reduced by iron to the metallic state at the temperatures involved. The ferrous oxide formed imparts a green color to the ground. (*Chem. Abs.*, **5**, 2163 (1911).)

***Havas, B.**

THE COEFFICIENT OF EXPANSION OF ENAMELS AND THEIR CHEMICAL COMPOSITION. See Mayer, M. (this *Bibliography*, p. 210).

COEFFICIENT OF THERMAL EXPANSION OF SHEET-IRON ENAMELS. See Mayer, M. (this *Bibliography*, p. 210).

EXPANSION COEFFICIENT OF SHEET-IRON ENAMELS. See Mayer, M. (this *Bibliography*, p. 208).

FUNCTION OF FLUORINE COMPOUNDS IN ENAMELS. See Mayer, M. (this *Bibliography*, p. 209).

FUNCTION OF THE GROUND ENAMELS. See Mayer, M. (this *Bibliography*, p. 210).

OPAQUE WHITE ENAMELS. See Mayer, M. (this *Bibliography*, p. 211).

REACTION DURING THE FUSION OF IRON ENAMELS (CONTAINING FLUORINE). See Mayer, M. (this *Bibliography*, p. 209).

WHITE OPAQUE ENAMELS. See Mayer, M. (this *Bibliography*, p. 211).

***Hayes, Anson**

PROCESS FOR TREATING IRON. See Diedericks, William J. (this *Bibliography*, p. 95).

•Heilmann, E.

WHITE CLOUDED ENAMELS. See Hillringhaus (this *Bibliography*, p. 153).

MANUFACTURE OF A WHITE TRANSLUCENT ENAMEL. See Hillringhaus (this *Bibliography*, p. 153).

OPAQUING AGENT FOR WHITE ENAMEL. See Hillringhaus (this *Bibliography*, p. 154).

ZIRCONIUM OXIDE AS A CLOUDING AGENT IN ENAMEL AND GLASSES. See Hillringhaus (this *Bibliography*, p. 154).

TRANSLUCENT GLASSES AND ENAMELS. See Hillringhaus (this *Bibliography*, p. 153).

Heilmann, E.

WHITE ENAMELS. Austrian Pat. 72,232, Aug. 10, 1916.—Mixtures of zinc and aluminum oxides or of magnesium and aluminum oxides are employed, which are previously heated to such high temperatures that they form spinels and with excess of the components of the mixture yield adsorption compounds of the spinels with the oxides. (*Chem. Abs.*, **11**, 880 (1917).)

Heilmann, E.

OPAQUING SUBSTANCES FOR WHITE ENAMELS. British Pat. 26,498, Nov. 18, 1912.—Mixtures of magnesium oxide and aluminum oxide or of aluminum oxide and zinc oxide, calcined to form a spinel, or, if excess of one of the components is used, a solid solution of the spinel. In order to increase the opaquing effect, about 10% of SnO_2, ZrO_2, TiO_2, SiO_2, or other white refractory material may be added, and the mixture then calcined. (*Chem. Abs.*, **8**, 1652 (1914); *Chem. and Ind.*, **33**, 259 (1914).)

Heilmann, E.

CLOUDING AGENT FOR MANUFACTURING WHITE ENAMELS. German Pat. 285,822, Nov. 24, 1911.—The clouding agent consists of a mixture of MgO and Al_2O_3 or of ZnO and Al_2O_3 which is so highly heated that spinels are formed or, with an excess of one of the components of the mixture, solid solutions of the spinels with MgO or Al_2O_3 result. The clouding agent may contain, in addition to the solid solutions, white refractory materials such as SiO_2, SnO_2, ZrO_2, or TiO_2, whereby the clouding effect is strengthened. A sufficient addition is 10% of the weight of the mixed oxides to obtain a marked increase in the clouding effect. The ignited mixture may be prepared more cheaply than the SnO_2 used heretofore in larger amounts. (*Chem. Abs.*, **10**, 1086 (1916).)

Heinstein, G.

TRANSPARENT GLAZES FOR IVORY AND WHITEWARE. *Sprechsaal*, **53**, 31, 44, (1920).—The yellow color of glazes containing Pb oxide, alumina, or quartz is not suitable for ivory and whiteware. The yellow tint disappears when the Pb oxide is completely replaced by any other metallic oxide, and by replacing only 0.25 equivalent of Pb oxide a good ivory glaze may be produced. If a little boric oxide is added somewhat less Pb oxide may be used. The following 3 mixtures are recommended: Frit: calcined soda, 15.90, 31.80, 47.70; chalk, 10.01, 20.02, 30.03; red lead, 171.32, 114.22, 57.11; Zettlitz kaolin, 7.76, 44.00, 43.00; quartz, 72.36, 75.38, 75.38; crystallized boric acid, 0.00, 62.03, 62.03. Mill mix: frit, 261.29, 289.62, 248.76; Zettlitz kaolin, 18.21, 20.70, 20.70 parts by weight. The first is suitable for ivory and inferior whites, and the second and third are suitable for ivory and good whites. ZnO is the most satisfactory substitute for Pb oxide in ivory glazes, but if black earth compounds must be used magnesia is the best substitute, then lime, strontia, and baryta, in the order named. ZnO and magnesia also reduce the tendency of the glaze to craze, except in the presence of boric acid. (*Chem. Abs.*, **14**, 3513 (1920).)

Heintz, Otto L.

ENAMELED ORNAMENT. U. S. Pat. 793,659, July 4, 1905.—The method of producing enameled ornaments which consists in applying a coat of enamel on a body, heating the same at a low temperature for drying the enamel and causing the same to stick to the body, cutting away parts of the enamel for producing ornamentation, and then heating the same at a high temperature for melting and hardening the enamel.

Heintz, Otto L.

ENAMELED ORNAMENT. U. S. Pat. 808,744, Jan. 2, 1906.—The method of producing enameled ornaments which consists in placing face upward a pattern bearing a design in relief, then applying a coat of powdered enamel upon the upturned face of the pattern, applying an adhesive to the article to be ornamented, bringing the adhesive coated surface while the same is turned downward in contact with the powdered enamel on the high parts of the pattern whereby the enamel is lifted off from the high parts of the pattern and transferred to the adhesive coated surface of the article; heating the article and the enamel for melting; hardening the enamel and causing it to adhere to the article.

Helzel, A.

MUFFLE FURNACE FOR ENAMELS AND POTTERY. British Pat. 10,067, May 21, 1895.—The muffle consists of an annular channel, one section of which serves as a firing chamber, one as a cooling chamber, and one as preliminary heating chamber. The goods to be fired are carried on trolleys running beneath the annular space and provided with supports projecting upward into the annular space. The lower part of the annular space is sealed by a sand joint. The process of firing can be carried out continuously by the rotary movement of the chain of trolleys along the annular muffle. An alternative method of construction is also described. (*Chem. and Ind.*, **15**, 450 (1896).)

***Hemsteger, S. E.**

MODERN FRIT FURNACE. See Stief, W. C. (this *Bibliography*, p. 302).

Henneman, J.

ENAMEL FOR COATING SHEET METAL. U. S. Pat. 517,454, April 3, 1894.—An enamel composed of a mixture of fluorspar, saltpeter, white sand, borax, mica, red lead, carbonate of potash, and cryolite with a suitable coloring oxide.

Henry, Arthur V.

MICROSCOPIC STUDY OF STRESSES IN GLAZES. *Jour. Amer. Ceram. Soc.*, **8**, 117 (1925).—Stresses in glazes are studied, making use of the microscopic method. The investigation indicates that differential coefficient of expansion is partially responsible for stresses in glazes. There are several possible explanations which may account for stresses in glazes. (1) Seger attributes stresses ordinarily to the differential coefficient of expansion between the body and the glaze. (2) Since a glaze is not a homogeneous substance, there will be a differential coefficient of expansion between the various sections of the glaze itself. (3) A glaze in cooling tends to crystallize. A change in volume accompanies crystallization, bringing about stresses. (4) New compounds may form after the glaze has become rigid and introduce stress. (*Chem. Abs.*, **19**, 1037 (1925).)

Henry, J. D.

FOUNDRY PRACTICE CAN AID THE ENAMELER. *Enamelist*, **1** [2], 9 (1923).—Some of the details that will help are as follows: (1) *Patterns:* (*a*) best made of metal, avoiding thin spots, (*b*) eliminate sharp edges, and (*c*) face to be enameled should be down

when metal is poured. (2) *Gates:* (*a*) should always be on the edge and not on the face, and (*b*) there should be two or more gates to the piece whenever possible. (3) *Pouring:* molds should be near the cupola, so that metal can be poured as hot as possible. (4) *Grinding:* fins, gates, lumps, scabs, and other defects can be touched up in the grinding room. (5) *Pickling:* avoid use of acid in cleaning the casting. It is porous and bound to absorb acid. If acid is necessary, the casting should be given a severe firing before sandblasting. (6) *Facing:* be as sparing as possible with foundry facing of all kinds; eliminate them entirely if possible. (7) *Sandblasting:* (*a*) use flint shot sand and (*b*) do not rattle castings to be enameled as long as others. (8) *Cupola practice:* (*a*) limits of ideal mix:

Silicon	2.50 to 3.00
Manganese	0.44 to 0.54
Sulphur	0.065 to 0.090
Phosphorus	0.640 to 0.690

(*b*) use as little foreign scrap as possible and (*c*) use of new iron will more than make up its extra cost in other places.

Henry, J. D.

SALVAGING DEFECTIVE CASTINGS. *Enamelist*, **2** [4], 20 (1925).—H. describes the use of a filler in paste form to fill small holes in defective castings. This filler is applied after sandblasting and before spraying. The requirements of such a filler are that it must adhere to the iron, vitrify at firing temperature, and develop a coefficient of expansion near that of enamel used to cover it.

Henze, W.

PREPARATION OF WHITE GLAZES AND ENAMEL WITHOUT TIN OXIDE. *Keram. Rundschau*, **34**, 193 (1926).—A number of opacifying media in various mixtures were tested. Boric acid and borax favored opacity most. A few mixtures with antimonates gave good white glazes; zinc oxide gave less satisfactory results. Zirconium oxide is the best substitute for tin oxide. Recipes and results with other opacifiers are communicated. (*Ceram. Abs.*, **6**, 322 (1927).)

Herbert, F.

METHOD OF LINING SPIGOT AND SOCKET, FLANGE, OR SNUG PIPES WITH ENAMEL, GLASS, COMPOSITION, OR OTHER MATERIAL. British Pat. 22,682, Dec. 13, 1892.—The pipes, having been molded or cast in the usual manner, are cleaned from sand, etc., the cores are removed, and the pipes are placed upon a "gantry" and caused to revolve in a furnace. A perforated tube, containing the enamel or glaze, is passed through the interior of the pipe and made to revolve, thereby distributing the enamel or glaze evenly upon the interior surface of the pipe. The heat of the furnace causes the enamel to melt and fix itself upon the surface of the pipe. (*Chem. and Ind.*, **13**, 154 (1894).)

Hermsdorf, L. and Wagner, R.

PROCESS FOR ENAMELING IRON. German Pat. 166,672, July 26, 1904.—In order to improve the fire-resisting qualities of the enamel and to render it opalescent, two glazes are used, one containing phosphoric acid and the other calcium compounds, whereby calcium phosphate is formed during the enameling process. Suitable compositions for glazes are:

	I (per cent)	II (per cent)
Potassium carbonate	9.2	5.3
Sodium carbonate	12.2	14.3
Alumina	10.0	5.9
Phosphoric acid	14.0	

	I (per cent)	II (per cent)
Boric acid	13.8	14.9
Silica	40.4	33.6
Nickel oxide	0.4	0.4
Sodium fluoride		5.2
Aluminum fluoride		3.5
Calcium fluoride		16.9

The glazes are mixed in the proportions of 100 parts of the first to 10 to 25 parts of the second. If a white glaze be desired, the nickel is left out. (*Chem. and Ind.*, **25,** 985 (1906).)

Herschel, Winslow H., and Berquist, Carl

CONSISTENCY OF STARCH AND DEXTRIN PASTES. *Ind. Eng. Chem.*, **13,** 703.—(1) The Bingham and Green plastometer is the best type of instrument available for determining the consistency of plastic substances, although there is need of further improvements in method so that the values obtained may be independent of the dimensions of the capillary. (2) Adhesives of the concentration in which they are used are mostly plastic, but differences in yield shear value and rigidity of different samples of the same concentration are very striking and significant. (3) Many more results are necessary for a complete understanding of the different products, but it has been shown that rigidity and yield shear value, as determined by the plastometer, will indicate the body, spreading power, and setting or gelatinizing power of starch and dextrin pastes. (*Chem. Abs.*, **15,** 3765 (1921).)

Hessl. Mitth., p. 659 (1844).

ENAMEL ON IRON. (*Rep. der Tech. Lit.*, p. 272 (1823–1853).)

***Hidnert, P.**

THERMAL EXPANSION OF INSULATING MATERIALS. See Souder, W. H. (this *Bibliography*, p. 284).

Higley, H. G.

ENAMELING IRON. U. S. Pat. 1,178,469, Apr. 4, 1916.—The iron is immersed in a bath prepared from dilute sulphuric acid, ferric oxide, and an enamel composition, and then enameled and fired as usual. (*Chem. Abs.*, **10,** 1587 (1916); *Chem. and Ind.*, **35,** 635 (1916).)

Hillringhaus and Heilmann

TRANSLUCENT GLASSES AND ENAMELS. German Pat. 189,364, Nov. 21, 1906.—Process of manufacturing translucent glasses and enamels, characterized by the substitution for stannic oxide of the cheaper zirconium oxide or zirconium-containing materials. (*Chem. Abs.*, **2,** 735 (1908).)

Hillringhaus and Heilmann

WHITE CLOUDED ENAMELS. British Pat. 12,583, May 30, 1907; *Chem. Fabrik Gustrow.*—Artificially produced titanates of alkaline earth or earth metals are used. White clouded enamels by use of zirconates or titanates. Yellowish color reduced by use of CoO or CuO. (*Chem. Abs.*, **3,** 587 (1909); *Chem. and Ind.*, **27,** 810 (1908).)

Hillringhaus and Heilmann

MANUFACTURE OF A WHITE TRANSLUCENT ENAMEL. German Pat. 207,001, Aug. 6, 1907; *Chem. Fabrik Gustrow.*—A small amount of cobalt oxide is added to the enamel material containing titanic acid with the view of covering the yellowish tint of the titanic flux. (*Chem. Abs.*, **3,** 2044 (1909).)

Hillringhaus and Heilmann

OPAQUING AGENT FOR WHITE ENAMELS. British Pat. 11,749, May 20, 1913; *Chem. Fabrik Gustrow.*—This consists of titanic acid and zirconium oxide. The titanic acid may contain alkalis and silicic acid. Composition of enamel may be as follows:

Borax	20.5	Na_2CO_3	8.0
Feldspar	30.4	KNO_3	2.7
SiO_2	19.7	Cryolite	16.0

Mill 100 kg. with { 4.5 kg. SnO_2 ; 1.5 kg. TiO_2 ; 7.0 kg. clay

(*Chem. Abs.*, **8**, 3622 (1914); *Chem. and Ind.*, **32**, 945 (1913).)

Hillringhaus and Heilmann

ZIRCONIUM OXIDE AS A CLOUDING AGENT IN ENAMELS AND GLASSES. *Z. anorg. Chem.*, **66**, 436.—In a paper on investigations of the uses of native ZrO_2, Weiss and Lehmann suggest its applicability as a clouding agent in the preparation of enamels and propose it as a substitute for the more expensive tin oxide, especially since it imparts to the enamel a high brilliance and great acid-resisting power. Hillringhaus and Heilmann call attention to the restriction entailed on the use of above suggestion, owing to previous patents granted to the chemical firm of Gustrow. They cite D.R.P. 189,364, Class 32b, Group II, "Method for the preparation of clouded glasses and enamels by the use of ZrO_2 or zirconia-containing substances as clouding agents." (*Chem. Abs.*, **5**, 167 (1911).)

Hinchley, J. W.

PERMANENT MOLDS FOR IRON CASTING. *Chem. and Ind.*, **46**, 423 (1927).—The great utility of permanent molds is pointed out, and the difficulties to be encountered are touched upon. The mold is made of two light hollow cast-iron molds, which are opened and closed by a toggle-joint mechanism. The thickness and outer surface are designed so as to insure a proper rate of removal of heat after the metal is poured. The inner surface is coated with a refractory, hard enough to resist the cutting action of the molten metal, of such a nature that no gases are formed in contact with the metal, and of right thickness to transmit the heat at a safe rate. After a casting is removed, the mold is cleaned by an airblast of 200 lbs. per sq. in., and is then coated with a layer of carbon $^1/_{32}$ inch thick from an acetylene flame. The mold may be set on a traveling table, and the casting ejected automatically at the right moment. (*Ceram. Abs.*, **6**, 327 (1927).)

Hines, J.

MAKING ENAMELED GOODS. U. S. Pat. 322,290, July 14, 1885.—Process to prevent enamel firing off the edges of articles as follows: The enameled plate is dipped at the edges into a glaze or flux of any suitable or desired color, finely ground in turpentine or other convenient vehicle, and the dipped plate is then fired. The flux or glaze being less refractory than the enamel of the plate or other article, it flows (owing to the heat) until it becomes quite level and forms a perfect surface, thus producing an ornamental border, which at the same time protects the metallic edges, which would otherwise be bare and liable to oxidize and rust.

Hines, J.

ENAMELING. U. S. Pat. 329,165, Oct. 27, 1885.—Enamel in a wet granular state is placed upon the metal so as to give an even compact surface. This surface is then covered with a stencil which is made of a flexible metal or paper treated with oil, glycer-

ine, or other suitable material or mixture, which will leave the paper soft and allow it to be laid down close to the wet enamel surface without becoming water-soaked. A dry powdered enamel, different in color from the body enamel, is then sifted over the surface protected by the stencil. The stencil is then removed, and the designs produced rolled down. The articles thus prepared are then dried and put through an enameling furnace.

Hines, Joseph H.

PROCESS OF ENAMELING METAL SURFACES. U. S. Pat. 674,506, May 21, 1901.—The process of enameling metallic surfaces, the same consisting in applying to the surface of the article a ground composition comprising powdered silicate, borax, lead, antimony, tin, arsenic, potash, and soda, firing to melt the composition and cause it to combine with the metallic surface without oxidizing the same and to form a protective ground-coating therefor, applying an enamel coating, firing to combine the enamel with the ground coating, applying a design or decorations to the enamel, firing to fix the same, applying a transparent acid and chemical-proof coating, and finally firing to fix such coating.

Hines, Joseph H.

PROCESS OF ENAMELING. U. S. Pat. 808,542, Dec. 26, 1905.—After cleaning, the metal is coated with an alkaline material, the enamel is then applied, a coloring coat applied and fired, and a second coat of enamel applied and fired. (*Chem. and Ind.*, **25**, 122 (1906).)

Hirsch, W.

ENAMELING FURNACE. German Pat. 283,869, Feb. 1, 1913.—Constructional details of a furnace for enameling metal and other articles. (*Chem. Abs.*, **9**, 2580 (1915).)

Hitachi Seisakusho, The

MANUFACTURING ENAMELED ELECTRIC RESISTANCE BODY. Japanese Pat. 10,033, Aug. 30, 1926.—Electric resistance coil, previously coated with water-glass or a mixture of water-glass and powdered silica, is painted with enamel and then fired. (*Ceram. Abs.*, **6**, 505 (1927).)

Hoelscher, Edward C., and Clifford, John

ENAMELING TABLE OR MACHINE. U. S. Pat. 645,393, March 13, 1900.—The combination in an enameling table, of a folding extensible or collapsible cast or muffler adapted to surround and protect the outside of the heated vessel or article to be enameled.

***Hogenson, W.**

ROTARY SPRAYING BOOTH. See *Ceramic Ind.* (this *Bibliography*, p. 52).

Hogenson, William

CHARGING APPARATUS FOR ENAMELING FURNACE. U. S. Pat. 1,468,944, Sept. 25, 1923.—Charging apparatus for enameling furnace, comprising in combination, a carriage having a removable work carrier, a furnace charging fork arranged to receive the work carrier when the latter is moved over the charging fork, tracks for supporting one end of the fork, and depressible rollers for supporting the other end of the fork. (*Ceram. Abs.*, **2**, 274 (1923).)

Hogenson, William

CHARGING FORK FOR ENAMELING FURNACES. U. S. Pat. 1,471,028, Oct. 16, 1923.—Charging means for enameling furnace comprising a traveling wheeled carriage, two

widely spaced sets of track bars secured on the carriage, and two fork frames mounted on rollers that travel on the track bars, each fork being movable independent of the other, and there being free and unobstructed loading and unloading passages between the sets of track bars, and between the fork frames, whereby either fork frame may be loaded and unloaded from either side. (*Ceram. Abs.*, **3**, 6 (1924).)

Hogenson, William

PRODUCTION CONTROL IN PORCELAIN ENAMELING. *Enamelist*, **4** [7], 15 (1927).—Excerpts from a paper read before Western Stove Manufacturers' Association. Methods of control for some of the operations and causes of some enameling difficulties are given.

Hoggson, S. J.

PRINTING AND DECORATING ENAMELED SURFACES. U. S. Pat. 144,979, Nov. 25, 1873.—Apparatus consists in a printing disk or roll supported upon a self-adjusting arm, and combined with an adjustable inking or fountain roll and a revolving table, and also in the mechanical adjustments of the same.

Holcroft, Harold

PRINCIPLES OF VITREOUS ENAMELING OF CAST IRON FOR INDUSTRIAL PURPOSES. *Chem. and Ind.*, **29**, 121 (1910).—Article deals with theory, principles, and difficulties of enameling practice. Four methods are discussed: (1) An undercoat of considerable thickness with a relatively high fusing point. This is applied in the wet way, dried and fired, and an upper coat enamel of a lower fusing point added. (2) A very thin special undercoat is applied in the wet way, dried, and fired right into the surface of the iron. There is then scarcely any visible coat, but the surface of the iron is affected so that the propensity to "bleb" is retarded, and an ordinary fusible uppercoat can be added. (3) A moderately fusible enamel is applied in the wet way direct upon the surface of the iron, dried, and fused. (4) One or more coats of a very fusible enamel are applied as a dry powder direct upon the red-hot surface of the metal. Methods (1), (2), and (4) can be used either upon the natural skin of the iron or upon a machined surface. Method (3), except in a very few cases, requires a machined surface. (*Chem. Abs.*, **4**, 1227 (1910).)

***Holdt, P. C.**

THE MEASUREMENT OF THE CONSISTENCY OF VARNISH. See Gardner, H. A. (this *Bibliography*, p. 127).

Holley, Everett D.

ENAMELWARE. U. S. Pat. 906,628, Dec. 15, 1908.—The combination, with a heat-enameled vessel having a flange, one side of which is free from the enamel coating, of a separately formed bottom having a plain metal flange for engaging the vessel flange and sealed thereto after the vessel body has been enameled, whereby a flat, smooth, unbuckled bottom will be attained.

Holmes, Harry N.

REMOVAL OF SCALE AND RUST FROM IRON AND STEEL. U. S. Pat. 1,470,225, Sept. 25, 1923.—The method of removing rust or scale from iron or steel, consisting in pickling the same in an acid bath containing at least $^1/_5$ of 1% by volume of an aldehyde to inhibit the attack of the acid upon the base metal. (*Ceram. Abs.*, **2**, 274 (1923).)

Honigmann, L.

ENAMEL FOR SHEET METAL AND OTHER HARD SURFACES. French Pat. 465,574, Dec. 1, 1913; British Pat. 28,398, Dec. 9, 1913.—Metallic silver is used in the undercoat as a substitute for cobalt or nickel oxide, or for a silver compound in solution in order

to make the enamel more flexible and adherent. (*Chem. Abs.*, **8**, 3495 (1914); *ibid.*, **9**, 1540 (1915); *Chem. and Ind.*, **33**, 355, 594 (1914).)

Horning, R. A.

THERMAL CONDUCTIVITY TESTS AND TRANSMISSION OF HEAT THROUGH BRICKS. *Trans. Amer. Ceram. Soc.*, **18**, 192 (1918).—Practically all methods are based on modifications of (1) hot air box or (2) hot plate method. Full discussions of various methods and calculations are given. (*Chem. Abs.*, **11**, 284 (1917).)

***Horny, R.**

IDENTITY OF TEMPER CARBON AND IRON GRAPHITE. See Lissner, A. (this *Bibliography*, p. 200).

Houghton, Eli K.

COATING WITH GLASS OR ENAMEL. U. S. Pat. 1,585,990, May 25, 1926.—An apparatus for applying coatings which consists of a pair of flexible conduits, nozzles mounted on the ends of the conduits, means for fastening the nozzles together in such a manner that the streams discharged therefrom intersect, valves mounted upon the nozzles, a fuel supply to which one of the flexible conduits is connected, a container containing a fusible comminuted material to which the other flexible conduit is connected, a conduit extending into the container for supplying compressed air thereto, and a valve upon the last-mentioned conduit controlling the supply of compressed air to the container. (*Ceram. Abs.*, **5**, 243 (1926).)

Houpt, Clayton

FISHSCALING OF SHEET-IRON ENAMELS. *Ceram. Ind.*, **6**, 41 (1926).—Fishscaling has been found to be caused by (1) faulty iron, (2) variation in clay, (3) underfiring and overfiring, and (4) overpickling. See this *Bibliography*, p. 57.

Houpt, C. S.

DATA ON ENAMELING. *Enamelist*, **1** [1], 11 (1923).—One square foot of steel.

Weight to piece	Ounces	Weight to piece	Ounces
Raw material	15	With first coat wet	17 1/2
Pickled material	15	With first coat dry	17
With ground coat wet	17	With first coat fired	17
With ground coat dry	16	With second coat wet	18 1/2
With ground coat fired	16	With second coat dry	18 1/2
		With second coat fired	18 1/2

	Ounces
Amount of ground coat	wet, 2 dry, 1
Amount of first coat	wet, 1 1/2 dry, 1
Amount of second coat	wet, 1 1/2 dry, 1 1/2

Wet, 5 oz.; dry, 3 1/2 oz.

***Howe, R. M.**

RÔLE OF CHLORIDE IN THE VOLATILIZATION OF FERRIC IRON (FROM ENAMEL). See Bole, G. A. (this *Bibliography*, p. 31).

Hughes, Josiah, and McGowan, James F.

ORNAMENTAL ENAMELWARE. U. S. Pat. 664,321, Dec. 18, 1900.—Variegated enamelware, the surface of which comprises a body having incorporated and fused therein an enameling material of different color.

Huin, M. B.

MUFFLE FURNACES, ENAMELING FURNACE, ETC. British Pat. 209,958, Feb. 1, 1923.—Muffle and similar furnaces of the type in which the muffle is entirely surrounded by heating channels or flues are so constructed that all the heating channels are in series so as to afford an equal draft for the hot gases. Advantages claimed are low fuel consumption, ease of draft regulation, and case of control. (*Chem. and Ind.*, **43B**, 239 (1924).)

Hulett, G. A.

PURIFYING CLAY, SAND, ETC. U. S. Pat. 1,368,396, Feb. 15, 1921.—Iron and other volatilizable substances are removed from clay, sand, or similar materials by heating the material to 350 to 600° and treating it with phosgene until the volatilizable substances are eliminated. The method is especially adapted for preparing ingredients of optical glass or clay pots for glass making. (*Jour. Amer. Ceram. Soc.* (Abs.), **4**, 696 (1921).)

Hull, Edgar L.

PRODUCING FLAT WATCH DIALS, ENAMELED ON ONE SIDE. U. S. Pat. 994,162, June 6, 1911.—Both sides are enameled and the enamel then removed from one side by the action of HF. (*Chem. Abs.*, **5**, 2540 (1911).)

Hull, S. M.

GLAZE, ENAMEL, OR GLASS COMPOSITION. U. S. Pat. 1,158,922, Nov. 2, 1915.—The composition contains metallic lead in the form of a powder substantially as impalpable as white lead, for which it is substituted. (*Chem. and Ind.*, **34**, 1251 (1915).)

Hull, S. M.

VITREOUS ENAMELS OR GLAZES FOR POTTERY, ETC. U. S. Pat. 1,159,264, Nov. 2, 1915.—Metallic lead is used as a substitute for white lead in making up the glazing compositions to effect a saving in weight and cost of lead required. The lead is used in about the same state of fine subdivision as that of white lead previously similarly employed. (*Chem. Abs.*, **10**, 261 (1916).)

Hull, T. E.

STUDIES GROWTH OF GRAY IRON. *Foundry*, **52** [7], 253 (1924).—The first growth of cast iron is due to occluded gases, which, being liberated under pressure, cause deformation of the graphite crystals. This opens up avenues for the entrance of the oxygen to the iron. The second stage of growth is due to oxidation of iron silicide. As the point of maximum growth is approached, some free iron is oxidized. (*Ceram. Abs.*, **3**, 214 (1924).)

Humphrey, E., and Hatschek, E.

VISCOSITY OF SUSPENSIONS OF RIGID PARTICLES AT DIFFERENT RATES OF SHEAR. *Proc. Phys. Soc.*, **28**, 274.

Humphries, C. H.

ENAMELING CADMIUM AND ZINC SURFACES. See Pierce, H. C. (this *Bibliography*, p. 235).

Hybinette, Noak Victor

HEAT-RESISTING ALLOY AND STRUCTURE, ETC. U. S. Pat. 1,563,573, Dec. 1, 1925.—Heat-resisting alloys containing from 10 to 20% of chromium, 30 to 40% of nickel, from 0.4 to 1.5% carbon, less than 1% silicon, and the remainder for the most part iron. (*Ceram. Abs.*, **5**, 46 (1926).)

Ibbotson, W. H.

SOME NOTES ON THE PICKLING OF STEEL. *Ind. Chemist*, **3**, 147 (1927).—The concentration of H_2SO_4 to be chosen for "pickling" steel is determined by the following: (*a*) class of material, (*b*) fineness, (*c*) depth of scale, (*d*) "pickling" capacity of the plant, and (*e*) time at disposal for "pickling." The most desirable temperatures for the bath lie between 180 and 200° F. Spent acid should be run off and replaced by fresh acid. HCl has a limited use for "pickling," as it is more expensive than H_2SO_4. "Pickle aids" help in reducing spray, but have a doubtful economical value in saving metal or acid. Spent liquors should be recovered, as $FeSO_4$ has a common value. (*Ceram. Abs.*, **6**, 568 (1927).)

***Illinois Refrigerator Co.**

INSTALL REFRIGERATOR ENAMELING PLANT. See *Enamelist* (this *Bibliography*, p. 107).

Incandescent Heat Co., Ltd., and Smallwood, A.

ENAMELING FURNACE. French Pat. 373,218, Sept. 17, 1906; British Pat. 18,877, Sept. 19, 1905.—The invention consists essentially in arranging above a horizontal combustion chamber a heating chamber for a number of crucibles, an annealing chamber, and a chamber for reheating, etc., all these chambers being so connected to the combustion chamber or to one another by heat-distributing passages, that heat may be easily supplied to or shut off from any part of any of these chambers. A jacketing chamber is placed so as to extend above all three chambers, the burnt gases passing from this into the chimney. (*Chem. Ind.*, **25**, 1049 (1906); *ibid.*, **26**, 610 (1907).)

Ind. Eng. Chem., **14**, 1164 (1922).

REPORT OF VISCOSITY COMMITTEE (Am. Chem. Soc., Cellulose Div.).—Method for measuring viscosity is proposed as follows: A 0.635 cm. ($^1/_4$ in.) steel ball is allowed to fall through the solution of which the viscosity is to be measured, the solution being contained in a cylindrical tube. The time in seconds which is required for the ball to pass between two marks 25.4 cm. (10 inches) apart is the viscosity in seconds. Specifications for the apparatus are given.

India Rubber World, Dec. 1 (1923).

RUBBER-LINED BALL MILLS IN MINING AND CEMENT INDUSTRIES. *Concrete*, **24**, 47 (1923).—After months of practical test, it was demonstrated that the innovation of the rubber lining gives results superior to any of the metal and rock linings previously used in ball mills for grinding very hard ore and gangue rock. The grade of rubber recommended is that used for the tread of automobile tires. While sufficiently hard to resist wear, it has enough resiliency to cause the steel balls or other grinding medium to rebound upon impact in such manner as to avoid disintegration of the linear surface. Also the rebounding action produces a very marked increase in pulverizing efficiency. A method of applying the rubber slabs is covered by U. S. Pat. 1,470,597. (*Ceram. Abs.*, **3**, 190 (1924).)

Ind. Z. Rig., **13**, p. 140.

ENAMELING OF IRONWARE. (*Rep. der Tech. Lit.*, p. 127 (1885–1887).)

Ind. Ztg., **20**, p. 326.

REMOVAL OF ENAMEL FROM VESSELS. (*Rep. der Tech. Lit.*, p. 142 (1879–1881).)

***Ingalls**

See Bingham, E. C. (this *Bibliography*, p. 24).

Ingersoll, O. R.

ENAMELING METALLIC SURFACES. U. S. Pat. 300,711, June 17, 1884.—The novel method of enameling metal plates, consisting in striking the edge of the plate below the general plane of the body of the plate and then applying the enamel to the plate.

***Ingram-Richardson Co.**

DOUBLE FURNACE OPERATED BY ONE CREW AT ENAMELING PLANT. See *Ceram. Ind.* (this *Bibliography*, p. 52).

Insley, Herbert

QUANTITATIVE MICROSCOPIC ANALYSIS OF COMMERCIAL FELDSPAR. *Jour. Amer. Ceram. Soc.*, **10,** 651 (1927).—This investigation was undertaken to develop microscopic methods for determining quantitatively the mineral constituents in feldspars used in the ceramic and allied industries. After several methods had been tried, a method of counting the grains and of using liquids of different indices of refraction for distinguishing the constituents was finally adopted. Nineteen commercial feldspars were analyzed by this method and the results compared with the results obtained by computing the chemical analyses to mineral constituents. Another method in which a partially fused sample was examined microscopically was also found suitable. It is concluded that, while neither the counting method nor the fusion method is as accurate as chemical analysis, the counting method gives satisfactory results for plant control in terms of potash feldspar, plagioclase feldspar, and quartz when used by a skilled microscopist, and the fusion method gives satisfactory results in the hands of the plant technologist for estimating quartz. (*Ceram. Abs.*, **6,** 468 (1927); *Chem. Abs.*, **21,** 3436 (1927).)

Iron Age, **94,** 10 (1914).

MANUFACTURE OF GRAY ENAMELED WARE.—Description of the plant and process of the General Stamping Co., Canton, Ohio. No data are given.

Iron Trade Review, **57,** 215 (1915).

USING ELECTRIC OVENS FOR ENAMELING.—Details of an interesting innovation in enameling practice made by a Toledo automobile builder.

Iron Trade Review, **59,** 1091 (1916).

HOW ENAMELED KITCHENWARE IS MADE.—Description of process used by the American Stamping & Enameling Co., Massillon, Ohio. Illustrations of different parts of the process and a diagram of the plan and elevation of the plant are shown. No data are given.

***Ironton (Ohio) Stove & Mfg. Co.**

ENAMEL PLANT BUILT ON THIRTY YEARS' EXPERIENCE HAS NEW IDEAS. See *Ceram. Ind.* (this *Bibliography*, p. 56).

Irresbeger

REFINEMENT OF CAST IRON BY SHAKING. *Engineering*, **122,** 249 (1926).—Practically all methods of refining cast iron are based on thermal or chemical processes. A new mechanical process by J. Dechesne, of Rostock, consists in subjecting the liquid metal to a violent shaking motion, which activates and accelerates such reactions as are known to occur therein. The iron is degassed and deoxidized; the components of the iron are thoroughly mixed, thus neutralizing the harmful effects of S; graphite is dissolved and a more finely grained structure is obtained. The process is carried out with a cupola furnace to which is connected a receiver, preheated, the front end of which is

raised and lowered 100 times a minute by cams. A slight horizontal motion, the receiver being carried in open bearings, "shakes" the liquid, as distinct from vertically "jolting" it, and the waves thus produced cause a lively evolution of gases, H, CO, SO_2, and a thorough mixing. (*Ceram. Abs.*, **6**, 51 (1927).)

***Iwatoro, Ito**

MAKING ENAMELED SHEET-IRON WARE WITHOUT GROUND COAT. See Tomekichi, Bessho (this *Bibliography*, p. 310).

***Jacques, A. G.**

FACTORS AFFECTING PLASTICITY OF PAINT. See Bingham, E. C. (this *Bibliography*, p. 24).

Jaeger, Frank

FISHSCALING OF SHEET-IRON ENAMELS. *Ceram. Ind.*, **6**, 42 (1926).—Fishscaling in one instance was traced to a change from 24- to 20-gage iron. The new iron if given less time in the pickling solution would work very well. Clay has also been found as a cause of fishscaling. In one case the trouble was eliminated by boiling the clay. For discussion see this *Bibliography*, p. 57.

Jaeger, F. G.

SMELTER LININGS. *Enamelist*, **2** [3], 5 (1924).—High iron content of firebrick lining causes many difficulties in enameling.

Jaeger, F. G.

SANDBLAST CASTINGS TO BE ENAMELED. *Jour. Amer. Ceram. Soc.*, **6**, 976 (1923).—Description of the sandblasting operation. Thorough cleaning can be accomplished only by sandblasting. Tests have shown that the downdraft ventilation of sandblast rooms is most efficient. Various types of sandblast rooms and equipment are discussed. Discussion of this paper by J. Grainer, J. F. Ritter, J. E. Hansen, M. E. Manson, H. F. Staley, W. C. Lindemann, L. D. Bridge, B. T. Sweely, and E. Hogenson, *Bull. Amer. Ceram. Soc.*, **2**, 3706 (1923); (this *Bibliography*, p. 41). (*Chem. Abs.*, **17**, 3911 (1923).)

***Jaeger, F. J.**

ZIRCONIA IN ENAMELS. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 41).

EFFECT OF MUFFLE ATMOSPHERE ON FIRING ENAMELS. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 43).

Jaeger, F. G., Cooke, R. D., Fellows, R., Jennings, A., Poste, E. P.

ENAMEL SYMPOSIUM. *Jour. Amer. Ceram. Soc.*, **10**, 451 (1927).—I. Effect of manganese dioxide on the physical properties of ground-coat enamels is: (1) to give a good gloss; (2) to give a harder enamel; (3) to reduce the coefficient of expansion of the glass in which it is used; (4) when used with cobalt a uniform color desirable in stove work is obtained; (5) no difference in the adhesion of the ground coat between enamels using manganese, cobalt, or combinations of dioxides is apparent; (6) no effect on chipping is apparent; (7) while not absolutely essential in ground coats, it is very desirable for use from an economy standpoint. II. A theory of ground-coat adherence based on the fact that part of the steel is oxidized to iron oxide which is partly absorbed by the fused enamel and into which some of the enamel penetrates is set forth, and an explanation given of various effects obtained. III. Most of the things which should be done to maintain control in making and firing of ground coats for sheet steel are emphasized. IV. The method of control for application of ground-coat enamel by weighing the amount of dry enamel on a sheet of metal of known area is described.

This is used to maintain a uniform consistency of the enamel. Other essential features which have in the past caused trouble to many enamelers are mentioned. (*Ceram. Abs.*, **6**, 265 (1927); *Chem. Abs.*, **21**, 2969 (1927).)

Jansen, Fred

GROUND-COAT FIRING ON STEEL. *Enamelist*, **3** [2], 17 (1925).—Description of the method used by the Wrought Iron Range Co., St. Louis, Mo. (1) Furnace: 54 inches wide, 10 feet long; full muffle and silicon-carbide lined. (2) Fuel: 24 to 26 specific gravity fuel oil; fuel gases are not allowed to reach ware. (3) Temperature: 1580 to 1600°F for gages up to 20; 1600°F for heavier gage. (4) Time of firing depends on (*a*) temperature of furnace, (*b*) gage of ware, (*c*) amount of enamel on piece, and (*d*) fineness of enamel.

Jankowsky, William

ENAMELING METALWARE. U. S. Pat. 691,268, Jan. 14, 1902.—Iron or steel is coated with a suitable primary coat (alkali carbonate) and an enamel coat containing a suitable percentage of primary or acid salt capable of decomposing the film. (*Chem. and Ind.*, **21**, 256 (1902).)

***Jenks, L. E.**

PLASTICITY OF CLAY. See Bancroft, W. D. (this *Bibliography*, p. 13).

***Jennings, A.**

ENAMEL SYMPOSIUM. See Jaeger, F. G. (this *Bibliography*, p. 161).

Jobe, John S.

METHOD AND APPARATUS FOR COATING OR ENAMELING METAL. U. S. Pat. 1,348,361, Aug. 3, 1920.—In the art of coating metal castings, the method which consists in supporting the casting to be coated in an inclined position with one of its surfaces exposed to coating operations, coating such surface, and then turning the casting into a reverse inclined position to expose its other surface without removing it from its support and coating the other surface, substantially as described. (*Jour. Amer. Ceram. Soc.* (Abs.), **3**, 772 (1920).)

Jobe, John S.

ENAMELING KILN. U. S. Pat. 774,478, Nov. 8, 1904.—An enameling kiln having in combination two chambers, two series of flues or combustion-passages passing from the ends of the kiln and connected to the chambers at the opposite ends, one of the series consisting of a larger number than the other series, an uptake between the chambers and a series of flues or combustion passages extending under one chamber and connected to the central uptake.

Johnson-Laird, W. B.

SOLDERING ENAMELWARE, ETC. British Pat. 153,445, Oct. 10, 1919.—In tinning and soldering porcelain enamelware, the solder is applied to the glazed surface of the enamel or to both the enamel and any exposed Fe portion, by use of a steel brush or other steel tool without the aid of a soldering-iron or flux. The surface is cleaned and brightened and the vessel then heated over a gas ring, etc. Solder is then applied by the steel tool, etc., until the surface is tinned and more solder is then applied. The solder may consist of 30% of Sn, 10% of Zn, and 60% of Pb. According to the provisional specification, the solder may consist of 75% of Sn, 15% of Zn, and 10% of Pb. (*Jour. Amer. Ceram. Soc.* (Abs.), **4**, 517 (1921).)

***Jones, B. D.**

GLASS MANUFACTURE: ENAMELS: GLAZES. See Kelly, A. A. (this *Bibliography*, p. 169).

Jones, Chester H.

ENAMELED STEEL MANUFACTURE. *Chem. Met. Eng.*, **25,** 883 (1921).—The enamel is prepared and applied by both the wet and the dry process. There are in general four different coatings used depending upon the service to which the ware is to be subjected. One is supplied for the malt industry only; the dairy, soft drink, and pharmaceutical trade use another type; the third enamel is designed to resist all and any degree of acidity, and finally a special coat is used which is more decorative and, while not compounded to combat acid, has a reasonable resistance to it. Raw materials ordinarily used are ground sand, quartz, feldspar, borax, cryolite, fluorspar, sodium and potassium compounds, and clay. The raw materials for making the frit are mixed by hand or in revolving drums. Five Abbé pebble mills and four special rotary smelters comprise the glaze-room apparatus. Ordinarily wet enamels are sprayed on the heavy pieces through the medium of a portable air-spray nozzle guided by the hand of the operator. Chemical plant ware may be treated by the dry process or dusting. In this case the metal surface is wetted and the dry powdered frit dusted on where it adheres to the water film. The equipment for firing enamel to the steel consists of a total of seven furnaces, four of which are the open type, two complete muffle type, and one vertical furnace of special design used for firing small articles that would involve waste of heat if treated in the large furnaces. This furnace consumes oil for fuel, the remainder burning coke. Muffle furnaces are employed largely for firing light ware, especially the light enamels, while the heavier steel pieces are fired in the open type. The temperatures range from 1500 to 2000°F. The temperature in any one firing depends on the enamel. Hoskins' pyrometers record the temperatures of each furnace. Adjacent to each battery of furnaces is one enamel application room. The coated ring or tank is picked up by a traveling charging crane and placed in the open-type furnaces, where it is revolved on a turntable while firing. The muffle furnaces are served by power tongs, which pick the pieces from tables moving on industrial tracks along the front of the battery and place them within the firing chamber in each case. The special upright circular kiln is charged through split doors in the top and is equipped with two firing holes located in the side near the bottom. The waste gases from all furnaces is conducted through waste-heat boilers in the power plant. (*Ceram. Abs.*, **1,** 83 (1922); *Chem. Abs.*, **16,** 472 (1922).)

Jones, Chester H.

ENAMEL-LINED APPARATUS. *Chem. Met. Eng.*, **25,** 927 (1921).—General description of the plant of the Elyria Enameled Products Co., Elyria, Ohio. (See preceding abstract.) The company makes three general grades of enamel (compositions not given) some of the uses of which are outlined in the following paragraphs. *Enamel No. 11*, which is applied to cast-iron ware, has been found to resist the action of inorganic acids such as hydrochloric, nitric, phosphoric, sulphuric, hydrobromic, hydriodic, aqua regia at any strength, and any mixtures of these. It is acted upon by hydrofluoric acid of any strength. It resists action of stannic chloride in hydrochloric acid, zinc chloride up to 300°C, gaseous hydrochloric acid, aluminum chloride, bromine, chlorine, iodine (moist or dry), tungstic oxide precipitation by hydrochloric and nitric, sulphur dioxide, thorium nitrate in nitric acid, and manganese dioxide with hydrochloric acid. It may be used for all organic acids, acid chlorides, and organic compounds, being particularly resistant to acetic vapors. It is successful in vessels for heating magnesium hydroxide under pressure for evaporating lime salts of sulphocarbolates or boiling sodium carbonate, for

ammonia and sodium or potassium salts of inorganic compounds, but is decomposed by caustic alkalis and is acted upon slightly by hot milk of lime. Sodium cyanide and similar salts are too alkaline and react with it. It is more resistant to alkalis than most enamels. *Enamel No. 20*, which is applied to steel, has been used successfully for all strengths of organic acids (hot or cold), ammonium sulphate, acetic anhydride, acetic acids of all strengths (but not vapors), brine, moist chlorine, hydrochloric acid in alcohol, hydriodic acid, lactic acid of all strengths (hot or cold), hot phenol, tin chloride plus 1% hydrochloric acid, zinc chloride solution, hot sulphur chloride, inorganic acids below 0.5% strength cold, sulphuric acid above 50% strength and mixed acids high in sulphuric acid, hot or cold. If the reagent is one which attacks iron severely, the enamel coat must be perfect, limiting the size to 600 gallons. If there is no severe action on iron, any size up to 3000 gallons can be had. The limiting size must be decided for each condition by itself. It is also used for hot carbonate, cold sodium hydroxide 10%, and hot ammonia. *Enamel No. 21*, which is also applied to steel, is used for all conditions of milk, such as milk heating, holding, mixing, etc.; for oils, fats, alcoholic solutions of shellac, ammonia, aniline hydrochloride, acetic acid, storage cold; ammonium nitrate, bleach liquor, dry chlorine, dry hydrochloric acid gas, cold beverage sirups involving citric acid, grape juice, hydrogen peroxide, tincture of iodine, making invert sugar, hot oil of peppermint, cold phenol, salicylic acid and hot acetic anhydride, dry sulphur dioxide, tannic acid, hot bromine, distilled water, and hot fuming sulphuric. The last has been handled more successfully by No. 21 than by other enamels. For perfect coats the sizes are limited to 1000 gallons. Otherwise any size up to 7000 gallons can be obtained. Here as with No. 20, the limiting size can be determined only after making a study of the case in hand. Cast-iron units may be used with 75 lbs. steam pressure in the jacket and up to 100 lbs. inside the still. It has a coefficient of heat transmission about $^1/_4$ that of copper. With steam, temperatures up to 160°C in the jacket can be obtained. Up to 225°C an oil jacket can be used. Superheated steam at 315°C has been used on the small units. The enameled units have also been heated by a direct, well-spread flame up to temperatures of 300°C, but such service is rather severe, limiting the life of the enamel. Steel units are usually heated by means of a steam jacket, the 500 gallon sizes permitting 30 lbs. pressure, the large ones, such as 3000 gallons, being limited to 10 lbs. pressure. The pressure within the tank may be $1^1/_2$ times as great as that in the jacket. The coefficient of heat transmission is about $^1/_3$ that of copper, using straw as a heating medium. Using oil in the jacket (which has been done up to 250°C) the coefficient drops to $^1/_5$ that of copper. (*Ceram. Abs.*, **1**, 83 (1922); *Chem. Abs.*, **16**, 472 (1922).)

Jones, F. W.

GLAZING AND ENAMELING KILNS. British Pat. 9281, April 19, 1906.—The kilns are of the tunnel type and contain longitudinal rails on which trolleys carrying the articles to be glazed or enameled are mounted. The tops of the trolleys are formed of firebrick slabs adapted to fit together end to end to form a continuous platform through the kiln. The side edges of the trolleys are bent over to dip into sand troughs along the sides of the tunnel, so that the platform of the trolleys, and the side and arch of the tunnel form a practically closed heating chamber. Heat is supplied from an exterior furnace and exterior heating flues to a space in the arch of the kiln, above the arch of the tunnel so that no smoke or gases can come in contact with the articles to be glazed. The heating space in the arch of the kiln is provided with a number of baffle walls, so that the kiln becomes gradually hotter from the entrance at one end of the kiln, up to the point where the furnace is situated, and gradually cooler from this point to the other or outlet end. Sprocket wheels and an endless chain provided with arms engaging the trolleys

are arranged below the latter, for the purpose of moving them along the kiln as required. (*Chem. and Ind.*, **26,** 873 (1907).)

Jong, H. G. Bungenberg de

VISCOMETRIC RESEARCHES ON LYOPHILIC SOLS. *Recueil des Trav. Chim. des Pays-Bas*, **42,** 1 (1923).—Although the viscosity of lyophilic colloids is but slightly different from that of the disperse medium, lyophilic colloids show a very pronounced increase in viscosity even for small concentrations. This property has been much studied but the certainty of the interpretation of the observed alterations in viscosity is inversely proportional to the extraordinary extent of the experimental material. Thus W. Ostwald (*Chem. Abs.*, **7,** 3874) summarized the following ten variables which can cause an alteration in the viscosity: concentration, temperature, degree of dispersity, solvate formation, electric charge or ionization, the previous thermal treatment, the previous mechanical treatment, inoculation with small quantities of more viscous colloids, time and addition of other substances. According to Hatschek (*ibid.*, **8,** 281) viscosity is also dependent on the rate of the shear. Hess (*ibid.*, **15,** 7) and Rothlin (*ibid.*, **14,** 1473) also discuss a shearing elasticity that changes the rate of flow. The latter concludes that a number of lyophilic colloids do not follow Poiseuille's law, which would make viscometric determinations on these colloids of illusionary importance. De Jong, on the contrary, is convinced that with certain precautions viscosity determinations may give an insight into the condition of emulsoid sols. A brief summary of his results follows: Usually an accuracy of more than a few per cent is all that can be claimed for the method usually used in the viscosity determinations found in colloid chemistry literature. The conditions necessary to obtain an accuracy of 0.1 to 0.2% are discussed. Stress is laid especially on two important sources of error: the systematic error in relation to the size and character of the capillary of the viscometer (Gruneisen, Wissensch., *Abh. d. Phys. Techn. Reichsanstalt*, **4,** 151 (1905)); and the defective method of setting the viscometer. Many viscosity measurements cannot be used as a basis for theoretical consideration because the flow is influenced by mechanical treatment. These deviations are ascribed not so much to the presence of a resistance to elastic deformation along with the frictional resistance of the liquid system, but to a greater extent to an alteration in the structure of the system itself, and consequently in the frictional resistance also. According to the conditions of flow, the gelatinizing aggregates (Bachmann, *Chem. Abs.*, **7,** 1435) formed in the deviating systems of Hatschek, Hess, and Rothlin would be broken down to different extents. Viscosity measurements on similar liquid gels are of little value in the study of the emulsoid soluble state even when they are made under large differences in pressure. The aggregates are never completely broken down to the smallest elements as is clearly shown by Rothlin's experiments. The viscometric method is of no use for studying gelatin, and coagulation processes. Rothlin's division of lyophilic solutions into two groups, the first of which follows Poiseuille's law exactly, and the second only for large pressures, cannot be maintained, since agar sol, which, according to Rothlin, at 27° shows deviations of more than 100%, follows Poiseuille's law exactly (within 0.1 to 0.2%) at 50°, *i.e.*, above the gelatin temperature (40°). Under these conditions agar sol behaves very simply in comparison with gelatin and other sols, hysteresis phenomena are completely absent, as well as complications due to changes in concentration and temperature. The latter are completely reversible above the temperature of gelation. The influence of previous mechanical treatment is completely absent. On dilution with electrolytes a final equilibrium is reached at once. The only alteration with the time that occurs in an agar sol is a slow decrease which must be attributed to a destruction (hydrolysis) of the disperse phase and for which a correction must be applied. It is

desirable to find the conditions for each of the sols that show deviation from Poiseuille's law under which this is no longer the case and in which they behave in all other respects like simple systems. A clearer insight into the condition of emulsion sols can then be obtained by accurate viscometry. (*Chem. Abs.*, **17,** 2661 (1923).)

Jooss, P. F., and Ficheroulle, H. E.

LUMINOUS ENAMELS. French Pat. 610,454, May 9, 1925.—The metal surface to be enameled is coated with a deoxidizing layer, then with a mixture of lead-free flux and unground phosphorescent zinc sulphide, with or without a small quantity of radioactive substance. The article is then fired rapidly until the flux just melts. The process is applicable to the enameling of glass and ceramic products. (*Chem. and Ind.*, **46B,** 779 (1927).)

Jordan

CONCERNING ENAMEL. *J. f. pr. Ch.*, **13,** 12. (*Rep. der Tech. Lit.*, p. 272 (1823–1853).)

Jour. Amer. Ceram. Soc., **1,** 74 (1918).

ACID-RESISTING ENAMELWARE.—Editorial on the conditions which have affected this branch of the industry. (*Chem. Abs.*, **12,** 2117 (1918).)

Jour. Amer. Ceram. Soc., **2,** 770 (1919).

CERAMIC PRODUCTS AT FIFTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES.—Editorial note on enameled ware exhibits at Chicago, Ill., Sept. 22–27 (1919).

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J. d. conn. us., **18,** 89.

ENAMEL ON VESSELS OF IRON. (*Rep. der Tech. Lit.*, p. 272 (1823–1853).)

J. d. conn. us., **22,** 78.

CONCERNING ENAMEL. (*Rep. der Tech. Lit.*, p. 272 (1823–1853).)

J. d. conn. us., **24**, 235.

RECIPE FOR ENAMELING IRON AND COPPER VESSELS. (*Rep. der Tech. Lit.*, p. 272 (1823–1853).)

J. Goldschm., **12**, 27F.

TECHNIQUE OF ENAMELING. (*Rep. der Tech. Lit.*, p. 185 (1891–1893).)

***Jungbluth, H.**

HARDNESS OF CHILL CAST IRON. See Goerens, P. (this *Bibliography*, p. 133).

Jungbluth, H., and Gummert, H.

PHOSPHIDE EUTECTIC IN CAST IRON. *Krupp Monatsh.*, **7**, 41 (1926).—The amount of phosphide eutectic in cast iron is smaller the lower the casting temperature. Annealing above 700° also decreases the amount of eutectic, because above 700° phosphorus rapidly diffuses into the ferrite constituent. The casting temperature has no effect on the grain structure, but annealing coarsens it. (*Ceram. Abs.*, **5**, 299 (1926); *Chem. and Ind.*, **45B**, 588 (1926).)

Kanashima, Shigeta

PRODUCING LUSTER ON BISCUIT, GLASS, OR ENAMELED WARE. Japanese Pat. 4430, April 22, 1925; supplement to patent 62,280.—Hot biscuit, glass, or enameled ware is brought into contact with arsenious acid, chloride or nitrate of bismuth, tin, iron, copper, strontium, barium, uranium, cobalt, chromium, gold, silver, or platinum to produce a luster on its surface. (*Ceram. Abs.*, **4**, 267 (1925).)

Karbstein, Henry

FISHSCALING OF SHEET-IRON ENAMELS. *Ceram. Ind.*, **6**, 42 (1926).—K. has always found the use of more feldspar than quartz in enamel ground coat batch to be sufficient to keep away from fishscale. Soda ash should be close to 8% and fluorspar never over 6%. For discussion see this *Bibliography*, p. 57.

Kardos, E.

REMOVING ENAMEL AND LIKE COATING FROM WASTE ENAMELWARE, ETC. British Pat. 100,118, Mar. 2, 1915.—The materials are submitted to a continuous hammering action in an apparatus adapted to break off the enamel, and to separate it automatically from its metal base, which latter is beaten to a shapeless mass, and automatically removed. (*Chem. and Ind.*, **35**, 470 (1916).)

Kaszper, Paul

ENAMEL GLAZING ON COOKING UTENSILS WITH ANTIMONY AS A CONSTITUENT. *Dingler's Polytech. J.*, **294**, 187.—For some time past, iron cooking utensils with an enameled glazing of especial brightness have been in the market. K. has investigated the composition of this enamel and also the action of vinegar upon it. The analysis gave the following results: SiO_2, 39.80; Al_2O_3, 10.04; SnO_2, 1.19; Sb_2O_3, 14.32; P_2O_5, 2.73; CaO, 0.36; K_2O, 7.72; Na_2O, 8.92; B_2O_3 (by difference), 14.92; 100.00. On boiling 8.9041 grams of the enamel in small pieces with 250 cc. of strong vinegar, 1.61% was dissolved, and on adding HCl and H_2S to the solution, an unmistakable precipitate of antimony sulphide was obtained. For the purpose of comparison, 400 cc. of the same vinegar were boiled in two new pots of equal size, one of which was glazed with the ordinary tin oxide enamel, and the other with the antimony enamel. In the case of the former, 0.3147 gram was dissolved; in the latter, 0.5036 gram. The greater amount of corrosion in the antimony glazed pot was also perceptible, and as in the first experiment

the antimony dissolved could be readily precipitated as sulphide. These results show that from a hygienic point of view the presence of such large quantities of antimony in enamel glazing requires the most serious attention. (*Chem. and Ind.*, **14,** 272 (1895).)

Kato, Kanichi

IMPROVEMENT ON PATTERN PAPER FOR ENAMELED WARE. Japanese Pat. 7393, Jan. 8, 1926.—The pattern paper is pasted on a wire-gauze which has 180 meshes or more per linear inch. The paper surface is put close to a ware and colored enamel is applied through the gauze by means of a brush. The ware is fired as usual. (*Ceram. Abs.*, **6,** 496 (1927).)

Kaufmann, J. S.

ENAMELING (INSIDE) METAL UTENSILS OR VESSELS. British Pat. 22,184, Nov. 6, 1899.—In the first place, a vessel of enamel, porcelain, or similar material, glazed on the inside, but rough on the outside, is produced. A coating of metal powder is then applied to the outside, and fired on, and upon this is deposited a thick metallic covering by electrolysis. (*Chem. and Ind.*, **19,** 1113 (1900).)

Kawakami, M.

HEAT OF PRECIPITATION OF CEMENTITE FROM MARTENSITE. *Sci. Rept. Tohôku,* **14,** 325 (1926).—Heat of precipitation increases proportionally to carbon content. For eutectoid steel it is 3.7 calories per gram from α-martensite, and twice as much from β-martensite. (*Ceram. Abs.*, **5,** 243 (1926).)

Kaya, S.

SOLIDUS LIME IN IRON-CARBON SYSTEM. *Sci. Rept. Tohôku,* **14,** 529 (1926).—The solidus lime, determined by electrical resistance, of Swedish steels ranging from 1.60% carbon (solidus point 1140°) to 0.23% carbon (solidus point 1444°) lay between the curve obtained by Carpenter and Keeling and that of Gutowsky. The solubility limit of cementite was 1.7% carbon. (*Ceram. Abs.*, **5,** 243 (1926); *Chem. and Ind.*, **45B,** 325 (1926).)

Kayser, Grothe

GLAZES. *Polyt. Z.*, p. 156 (1876). (*Rep. der Tech. Lit.*, p. 54 (1876).)

Kebler, L.

RHEOSTAT. U. S. Pat. 1,321,104, Nov. 11, 1919.—A ground coat and a glaze are applied to the cast-iron base and fired. A second ground coat and glaze are then applied upon this and the whole fired. The resistance elements are placed upon this second glaze surface, covered with a third glaze or enamel, and the whole again fired. With the interposed relatively infusible ground coats there is no danger of the resistance elements sinking through the glaze and contacting with the base during the final firing. (*Jour. Amer. Ceram. Soc.* (Abs.), **3,** 85 (1920).)

Kebler, Leonard

ENAMELING RESISTANCE UNITS. U. S. Pat. 1,361,869, Dec. 14, 1920.—The method of enameling tubular units which consists in applying enamel material on them, and heating them electrically from within. (*Jour. Amer. Ceram. Soc.* (Abs.), **4,** 255 (1921).)

Keene, S. D.

ENAMELER'S APPARATUS. U. S. Pat. 412,853, Oct. 15, 1889.—The improved holder for enamelers' use consisting of a piece of bent metal arranged to frictionally engage the interior surface of a bobbin or other article to be enameled, and having the

free end of the wire terminating in a pusher, formed by bending the free end of the wire in an outward direction.

Kelly, A. A., and Jones, B. D.

GLASS MANUFACTURE, ENAMELS, GLAZES. British Pat. 160,495, Nov. 20, 1919.—In the manufacture of glass, vitreous enamels, and glazes, sodium pentaborate is substituted for borax or boric acid, and the necessary adjustment of the alkali content is made in any suitable manner. (*Jour. Amer. Ceram. Soc.* (Abs.), **4,** 1009 (1921); *Chem. Abs.*, **15,** 2345 (1921).)

Kelsey, V. V.

NORTH CAROLINA FELDSPAR. *Ceramist,* **8,** 524 (1926).—The fact that during the past 2 years one-half the feldspar consumed in America was produced in N. C. shows that the feldspars from the south are playing no small part in the present industrial expansion. Although the beginning of the industry a few years ago was not altogether auspicious, the mining operations today compare favorably with the most up-to-date in this country. (*Ceram. Abs.*, **6,** 74 (1927).)

Kenkel, Julius F.

ENAMELING. U. S. Pat. 804,010, Nov. 7, 1905.—An iron or steel article which has a fundamental coat composed of clay and an oxidizing agent and a separately applied glaze coat covering the fundamental coat and forming therewith a mottled finish.

Kenkel, Julius F.

MANUFACTURE OF ENAMELWARE. U. S. Pat. 779,655, Jan. 10, 1905.—The plate is coated with a preparation of enamel, fired, the plate then slushed in an enamel preparation, and the enamel evenly distributed by a blast of air.

Kennedy, H. E.

ENAMELING CAST-IRON WARE IN ELECTRIC FURNACES. *Chem. Met. Eng.*, **30,** 219 (1924).—The success of an electric kiln depends on adequate heat insulation, a low temperature gradient between the element and the surrounding material and proper heat distribution. Infusorial earth gives insulation. Ni-Cr ribbon resistors showed no diminution of cross-section to two years' operation at 1900°F. Resistors are placed in slots in special brick so as not to project into the kiln chamber. The terminals are at opposite sides of the furnace so as to prevent short-circuits. Automatic temperature control is used. Each of seventeen heating elements is independent, one or two being used for temperature control while the remainder are on all the time. Electric heat is a little cheaper than oil at $1.25 per barrel. Power rate is not given. (*Ceram. Abs.*, **3,** 240 (1924); *Chem. Abs.*, **18,** 1373 (1924).)

Kenrick

ENAMEL FOR CAST IRON. *Civ. eng.*, p. 27 (1847); *Lond. j. c. s.*, **29,** 416; *Dingler's Polytech. J.*, **103,** 369. (*Rep. der Tech. Lit.*, p. 272 (1823–1853).)

Kentonwski, L.

MUFFLE FURNACE FOR ENAMELING LARGE CAST-IRON KETTLES. *Stahl u. Eisen,* **32,** 2179 (1912). (*Chem. Abs.*, **7,** 2102 (1913).)

Keram. Rundschau, **16,** 89–91; 135–39 (1908).

ENAMELING OF SHEET-IRON HOLLOWWARE.

ENAMEL WITHOUT GROUND COAT

Feldspar	344	Mill 94% of this frit with 6% of kaolin
Borax	331	
Quartz	185	
Calcined soda	66	
Saltpeter	45	
Fluorspar	26	
Antimony oxide	3	

TRANSPARENT COLORLESS ENAMEL

Borax	347	Mill 96% frit with 4% kaolin
Quartz	274	
Feldspar	211	
Calcined soda	84	
Fluorspar	53	
Saltpeter	31	

DARK BLUE ENAMEL

Feldspar	500	Mill 96% frit with 4% clay
Borax	270	
Fluorspar	107	
Calcined soda	67	
Cryolite	41	
Cobalt oxide	14	
Saltpeter	7	

In the preparation of these enamels, artificial cryolite has been used successfully and it was found that tin oxide could be replaced by zirconium oxide at a saving of 33%. (*Chem. Abs.*, **2**, 1605 (1908).)

Keram. Rundschau, **20**, 70 (1912).

ENAMELING ON METAL.—The objects are uniformly moistened with water containing some mucilage-like substance. The moistening may be done by means of a steam jet or sprayer. The enamel powder is then sieved upon the prepared surface resulting in uniform application. (*Chem. Abs.*, **6**, 3504 (1912).)

Keram. Rundschau, **21**, 380 (1913).

INFLUENCE OF SULPHUR DIOXIDE USED AS A DISINFECTANT UPON SHEET-STEEL ENAMEL.—Dry or water-laden sulphur dioxide is without effect upon perfect ware, but on ware eshibiting crazing defects, yellow spots are formed in the defective spots of the enamel. If the ware itself is wet, however, the sulphur dioxide fumes exert vigorous effect, due to sulphuric acid formation. (*Chem. Abs.*, **8**, 224 (1914).)

Keram. Rundschau, **18**, 495, 507, 520 (1910); *Stahl u. Eisen*, No. 36 (1910).

MUFFLE KILNS FOR IRON ENAMELING AND OTHER INDUSTRIAL PURPOSES.—An exhaustive and excellent discussion of the design and construction of enameling muffle kilns. (*Chem. Abs.*, **5**, 580 (1911).)

Keram. Rundschau, **23**, 221 (1915).

NEW OPACIFIER FOR WHITE-IRON ENAMELS.—Magnesium oxide and aluminum oxide, or zinc oxide and aluminum oxide are heated together to form a spinel. By using 5% of these and 0.5% of a stronger opacifier instead of 10% spinel, the opacity is improved. (*Chem. Abs.*, **10**, 1416 (1916).)

Keram. Rundschau, **24**, 5 and 29 (1916).

ZINC SULPHIDE AS AN OPACIFYING AGENT.—Addition of not more than 5% of zinc sulphide produces opaque enamels. It cannot be used for cooking vessels owing to its poisonous nature. (*Chem. Abs.*, **11**, 3106 (1917).)

Keram. Rundschau, **32**, 37 (1922); (Taschenbuch fur Keramiker).

ENAMELS FOR TINWARE.

TABLE I. GROUND COATS

Frit	I	II	III	IV	V
Boric acid	0.0	0.0	0.0	0.0	240.0
Borax	371.0	32.0	44.0	374.0	115.0
Feldspar	333.0	28.0	31.0	335.0	96.0
Quartz	192.0	20.0	17.0	196.0	231.0
Calcined soda	45.0	6.0	3.0	56.0	0.0
Fluorspar	37.0	3.0	4.0	39.0	38.0
Whiting	0.0	9.0	0.0	0.0	0.0
Potassium nitrate	22.0	2.0	1.0	0.0	0.58
Manganese silicate	0.6	0.5	0.0	0.5	212.0
Cobalt oxide	0.3	0.2	0.1	0.25	0.0
Nickel oxide	0.0	0.0	0.1	0.0	0.0
Magnesia	0.0	0.0	0.0	0.0	10.0
Mill mixture					
Frit	94	92		94	90
Clay	6	8		6	10

TABLE II. WHITE ENAMEL

Frit	I	II	III	IV	V	VI
Feldspar	386.0	0.0	220.0	235.0	353.0	32.0
Quartz	190.0	297.0	175.0	314.0	205.0	8.0
Borax	154.0	229.0	300.0	162.0	168.0	26.0
Calcined soda	0.0	117.0	135.0	93.0	0.0	9.0
Cryolite	117.0	0.0	0.0	157.0	120.0	5.0
Potassium nitrate	65.0	80.0	20.0	31.0	64.0	3.0
Whiting	65.0	0.0	0.0	0.0	70.0	0.0
Fluorspar	13.0	0.0	0.0	0.0	20.0	6.0
Magnesite	10.0	0.0	0.0	0.0	0.0	0.0
Magnesia	0.0	37.0	0.0	8.0	0.0	0.0
Tin oxide	0.0	240.0	150.0	0.0	0.0	11.0
Mill mixture						
Frit	84	94		90	85	86
Tin oxide	10	2		6	10	8
Quartz	0	4		0	0	0
Clay	6	0		4	5	6

Colored enamels are obtained by the addition of the following ingredients: (1) *Violet* (manganese silicate). (2) *Green:* copper oxide with or without iron oxide or chromium oxide. With the last oxides one obtains only a translucent green, since tin oxide produces a pink tinge. Cryolite also spoils the green color. (3) *Brown:* cobalt oxide and manganese silicate. (4) *Red:* for a cheap red, iron sulphate is calcined with alumina until the body takes a good red color. This color is then added to the enamel in a predetermined amount. Cadmium selenide and copper oxide and gold produce good red colors. (5) *Rose:* manganese oxide. (6) *Orange:* red ocher. (*Ceram. Abs.*, **1,** 168 (1922); *Chem. Abs.*, **16,** 1843 (1922).)

Keram. Rundschau, **34,** 67 (1926).

MICROSCOPIC EXAMINATION OF OPACIFIERS IN ENAMELED WARE.—The appearances of enamels under the microscope when opacified with fluorspar and cryolite are described. (*Ceram. Abs.*, **5,** 143 (1926); *Chem. Abs.*, **20,** 1894 (1926).)

Kerpely, K. von

HIGH-QUALITY CAST IRON PRODUCED IN AN ELECTRIC FURNACE. *Stahl u. Eisen*, **45,** 2004 (1925); *Chem. and Ind.*, **45B,** 92 (1926).—By treating cast iron in a Nathusius electric furnace of 4- to 6-ton capacity, cast iron with high carbon and phosphorus (C 3.0 to 3.2%, P 0.8%) may be produced with as good mechanical properties as high-quality cast iron of lower carbon and phosphorus made in a cupola. A special slag is

used, which consists of crude lime, fluorspar, and powdered coke, and the casting temperature is 1500 to 1600°C. Owing to quick cooling, the graphite and phosphide eutectics are uniformly distributed in a fine network. Analysis and mechanical properties are given of a large number of heats made when feeding the electric furnace by three cupolas which had been charged with low-grade scrap high in phosphorus, carbon, and silicon. Equally good tensile properties were obtained as when pig iron was used. (*Ceram. Abs.*, **5,** 143 (1926).)

Kerstan, A.

RESISTANCE OF ENAMEL TO ATTACK BY MINERAL ACIDS. *Sprechsaal*, **59,** 708 (1926); *Chem. Zentr.*, **1,** 342 (1927).—Enamel is attacked most readily by hydrochloric acid and nitric acid when the acids are of 25 and 35% strength, respectively. Hydrochloric acid attacks the borates and part of the alkalis; nitric acid dissolves principally sodium oxide, potash enamels being far more resistant to its action. (*Ceram. Abs.*, **6,** 374 (1927); *Chem. and Ind.*, **46B,** 411 (1927).)

Kerstan, Walter

SPECIAL ACID-RESISTING ENAMELS. *Ceram. Ind.*, **8,** 570 (1927).—Formulas are given for special acid-resisting enamels. High silica and alumina, boric acid and zinc oxide are conducive to good acid-resisting enamels. A special cooling is necessary to prevent the appearance of hairlines. The trend of acid-resisting enamels is toward the composition of Jena chemical glassware. An electrical method for testing the porosity of enamels is described. Tests to determine the resistance that enamels offer to chemical action are described. (*Ceram. Abs.*, **6,** 266 (1927).)

Kerstan, Walter

SPECIAL OXIDE FOR ACID-RESISTING ENAMEL. *Ceram. Ind.*, **8,** 665 (1927).—A formula of an acid-proof enamel used for cast-iron sanitary enameled ware is given. The formula contains "meltoxyn" which increases the acid resistance of the enamel and acts as an opacifier which is equal to that of tin oxide. The composition of "meltoxyn" is not given. Formula for acid-proof enamel to be used for cast-iron sanitary enameled ware:

Sand	28	Soda ash	30
Feldspar	24	Fluorspar	3
Ground glass	76	Zinc oxide	3
Boric acid	32	Meltoxyn	24

The ground glass has the following formula and appears to be close to a soda lime glass: SiO_2 72.0, Al_2O_3 7.5, CaO 5.5, MgO 2.0, and Na_2O 13.0. (*Ceram. Abs.*, **6,** 327 (1927).)

Ketcham, George W.

ART OF ENAMELING METALWARE. U. S. Pat. 708,363, Sept. 2, 1902.—The cleaned article is coated with a thin layer of cohesive and noncorrosive metal and an enamel then applied which, upon heating, will coact with and only partially oxidize and permeate the coating metal. The enamel has the following composition:

	Lbs.		Lbs.
Feldspar	500	Potassium nitrate	50
Borax	300	Fluorspar	25
Soda ash	15	Cryolite	50

Coloring matter, such as cobalt or manganese, are also added. (*Chem. and Ind.*, **21,** 1232 (1902).)

***Kikuta, Ferio**

GROWTH OF CAST IRON. See *Chem. Met. Eng.* (this *Bibliography*, p. 65).

Kinnison, C. S.

HEAT-RESISTING RACKS AND POINTS. *Enamelist*, **2** [2], 22 (1924).—Heat-resisting alloys, racks and points save their cost from the following sources: (1) reduction in warped ware, (2) reduction of losses in seconds or discounts, and (3) saving in actual points and racks.

Kinnison, Chas. S.

DEVELOPMENT OF ALLOY ENAMELING RACKS. *Enamelist*, **3** [3], 14 (1925).—Short history of the introduction of these racks into the enameling industry. Equipment made of this alloy does not warp or scale, has higher resistance to oxidation and to the dissolving action of enamel, is very much lighter, and lasts much longer than iron.

Kinnison, Charles S.

ATTERBERG PLASTICITY METHOD. U. S. Bur. Stand., *Tech. Paper*, No. 46 (1915).—The practical significance of the Atterberg factor and the rating of clays based on shrinkage or water of plasticity are discussed. The Atterberg factor when used alone is of little significance, but when coördinated with the water of plasticity, as recommended in this paper, it appears to be possible to differentiate between the nonsticky or safe-working clays and the sticky varieties which are difficult to work. (*Chem. Abs.*, **9**, 2300 (1915).)

Kinzie, C. J.

RESULTS OF CERTAIN RESEARCHES RELATIVE TO THE DEVELOPMENT AND USE OF ZIRCONIUM OXIDE PRODUCTS AS OPACIFYING AGENTS IN VITREOUS ENAMELING PROCESSES. Pamphlet of The Titanium Alloy Co., 1924.—(1) Zirconium oxide, in order to be suitable as a substitute for tin oxide in producing opacity in vitreous enameling work, must have properties other than a high degree of chemical purity. (2) Zirconium oxide, in order to be a satisfactory substitute for tin oxide, must inherit from process, incidental to its production, a certain physical structure conducive to production of maximum opacity when introduced into enamels. (3) The comparative apparent opaquing strength of a suitable zirconium oxide material will vary somewhat depending on the enamel frit used in making tests. (4) A zirconium oxide opacifier has been developed by the Titanium Alloy Manufacturing Co. and is offered for sale under the trade name "Opax." (5) Opax is produced in such manner as to develop the maximum degree of opacity possible per unit of zirconium oxide content. (6) Opax can be used to replace tin oxide in enamels for sheet iron or steel when introduced as a mill addition. (7) Opax can be used to replace tin oxide in wet-process enameling of cast-iron ware. (8) Opax can be used to replace tin oxide as a mill addition opacifier in dry-process enameling of cast-iron ware. (9) Enamels of great opacity, high luster, and suitable color tone can be produced by smelting Opax into certain enamel compositions.

Kinzie, C. J.

ZIRCONIUM OXIDE CONCENTRATE AND METHOD OF PRODUCING THE SAME. U. S. Pat. 1,494,426, June 3, 1924.—In the derivation of zirconium oxide from material composed of compounds of zirconium associated with undesired substances, the steps which consist in mixing and heating the material with sulphuric acid; adding water to production of a zirconium sulphate solution, and adding to the solution chloride of sodium. (*Ceram. Abs.*, **3**, 241 (1924).)

Kinzie, C. J.

ZIRCONIUM OXIDE IN ENAMELS, ETC. U. S. Pat. 1,562,890, Nov. 24, 1925.—Crude material containing ZrO_2 as its principal constituent is mixed with a relatively small quantity of independently vitrifiable ingredients such as a glass-yielding frit and the charge is heated to decompose and eliminate impurities and produce an enamel opacifier. (*Chem. Abs.*, **20**, 488 (1926).)

Kinzie, Charles J.

ZIRCONIUM OXIDE COMPOSITION FOR OPAQUING GLASS OR ENAMELS. U. S. Pat. 1,588,476, June 15, 1926.—A zirconium oxide compound characterized as being a calcined product, of specific gravity of about 5.00, essentially white in color, as consisting by analysis preponderatingly of unfused zirconia and containing also a less quantity of commingled basic and acid-forming ingredients. (*Chem. Abs.*, **20**, 2569 (1926).)

***Klein, A. A.**

RAPID MEANS FOR DETERMINATION OF QUARTZ CONTENT OF FELDSPARS. See Booze, M. C. (this *Bibliography*, p. 32).

Klinefeldt, H. J.

BALL AND PEBBLE MILLING FOR PULVERIZING AND MIXING. *Ceramist*, **1**, 164.—A paper read before the Seventh National Chemical Exposition in which K. discusses the uses of these mills. (*Ceram. Abs.*, **2**, 5 (1923).)

Kling, A., and Lassieur, A.

DETERMINATION OF SULPHUR IN IRON. *Chim. et Ind.*, **15**, 699 (1926).—The evolution method of determining sulphur in cast iron and steel is as accurate as gravimetric methods provided that the metal is dissolved sufficiently rapidly to prevent absorption of organic compounds from the gas stream by the zinc acetate solution. The acid used should be 3 volumes hydrochloric acid (density 1.19) to 1 volume water, and the CO_2 stream should be interrupted during the solution of the metal, being used solely to drive air from the apparatus before starting, and to remove the remaining gas after finishing the process. (*Ceram. Abs.*, **5**, 299 (1926); *Chem. and Ind.*, **45B**, 588 (1926).)

Klissner, J.

KILN FOR ENAMELED ARTICLES. German Pat. 203,296, April 10, 1907.—Articles do not come in contact with flame. The combustion chamber has two arches, provided with openings through which the fire gases pass on their way to kiln. The side walls of the kiln are removable, and one wall allows direct communication with the cooling chamber, so that the articles can be removed thereto without coming in contact with the air. (*Chem. and Ind.*, **27**, 1204 (1908).)

***Knight, F. P., Jr.**

FREE QUARTZ IN FELDSPAR. (Discussion.) See *Ceramist* (this *Bibliography*, p. 62).

Knowles, W. V.

CONTROL TESTING OF BORAX AND SODA ASH STOCKS USED IN SMELTING OF ENAMEL FRITS. *Bull. Amer. Ceram. Soc.*, **6**, 132 (1927).—A simple method for routine control of borax and soda ash involving the installation of a few pieces of chemical apparatus in the mixing room is submitted. By titration of a solution containing known weights of the materials to be controlled it is possible to determine the percentage of the dry material and of the moisture contained therein, making it possible to rectify the weight introduced into the batch so as to allow for the moisture. (*Ceram. Abs.*, **6**, 265 (1927); *Chem. Abs.*, **21**, 2775 (1927).)

Koch, Francis M.

CHARGING FORK FOR ENAMELING FURNACES. U. S. Pat. 1,534,649, April 21, 1925.—A charging fork for furnaces including means for moving the fork into the furnace coöperating mechanism set in operation by the inward movement of the fork for automatically moving the fork vertically within the furnace, and coöperating mechanism set in operation by the vertical movement of the fork for automatically withdrawing the fork from the furnace. (*Ceram. Abs.*, **4**, 156 (1925).)

Kochs, E., and Seyfert, F.

ESTIMATING THE FUSIBILITY OF ENAMELS AND SILICATES. *Zeits. angew. Chem.*, **14**, 719 (1901).—Hitherto it has been impossible to judge the properties of enamels from their percentage composition, and to improve a given enamel it has always been necessary to carry out wasteful experiments. The authors obtain figures representing the fusibility of silicates by calculations based on their percentage composition; by dividing the number representing the percentage composition of each constituent, simple or compound, by its molecular weight, and dividing those numbers obtained representing fluxing bases by those representing silicic acid, a quotient is obtained which indicates the fusibility of the material. On examining clays by this method of calculation, the "fusibility quotient" of those which may be considered fireproof is a number always greater than 1; in the case of enamels, glazes, etc., the "fusibility quotient" is a proper fraction. The method is applied to the investigation of the "Seger cone" system of determining high temperatures, and certain errors in it are pointed out. Typical fusibility quotients are given as follows:

Blast-furnace slag, iron	0.008	Rolled glass	0.0002
Blast-furnace slag, copper	0.003	Bohemian glass	0.00004
Blast-furnace slag, lead	0.002	Bohemian glass	0.00002
Basic Bessemer slag	0.002	Rolled glass (faulty, soft)	0.00001
Pottery glaze	0.007		
Stove tile glaze	0.003		
Jena glass (alkali-free)	0.0027		

(*Chem. and Ind.*, **20**, 989 (1901).)

Koepp, R., and Co.

ENAMELS. British Pat. 100,777, Feb. 18, 1916.—Glass with low melting point is used to replace the usual fluxes. The quartz and feldspar in enamels may also be replaced by glass and an addition of an amount of clay corresponding with the alumina in the feldspar, the clay serving also to counteract an inferior capacity for spreading caused by the large addition of glass. It is found to be of advantage to use glass in conjunction with large amounts of alkali compounds, such as alkaline silicate or bisulphate. Glass may first be melted with Na_2CO_3, the finished fused product being then used as a substitute for borax, quartz, and feldspar in the enamel mixture. By using large quantities of glass, it is found possible to utilize the natural boron and calcium compounds or alkaline earths comprised under the names of boric or borax lime, such as borocalcite, colemanite, boronatrocalcite, and boracite, in place of pure borax. The quantity of glass to be added has to be ascertained in each case by a test, and sometimes the quantities of other constituents containing lime have to be reduced. The presence of the glass diminishes the injurious effects of salts such as chlorides or sulphates found in the boric lime. If boric lime is used in a formula containing fluorspar, the per cent of fluorspar is, wholly or in part, replaced by NaF, according to the per cent of lime in the boric lime. If raw materials containing MgO are used, the MgO should be counted as lime. Enamels prepared from boric lime adhere firmly, probably owing to an etching action

caused by impurities in the lime. (*Chem. Abs.*, **10,** 2791 (1916); *Chem. and Ind.*, **37A,** 124 (1918).)

Koepp, R., and Co.

ENAMELS. British Pat. 101,802, Feb. 18, 1916.—The use of natural borates is facilitated by the addition of large quantities of glass. Where in addition to boron compounds, the enamel normally contains fluorides, *e.g.*, fluorspar, such fluorides are replaced by alkali fluoride compounds, *e.g.*, cryolite or sodium fluosilicate; or where it normally contains quartz or feldspar, this is replaced by clay and glass. The glass employed preferably contains a high per cent of alkali; ordinary common glass may be enriched with alkali by mixing it with suitable alkali salts, such as alkali carbonate, silicate, or bisulphate, and coal. The glass may also contain boron, lead, or fluorine compounds. Water-glass may be employed. (*Chem. Abs.*, **11,** 294 (1917); *Chem. and Ind.*, **36,** 388 (1917).)

Koepp, R., and Co.

PRODUCTION OF ENAMELS. British Pat. 107,392, Mar. 28, 1916.—In the manufacture of foundation enamels wherein the oxides of cobalt and nickel are employed to secure adhesion, replacing the pure oxides wholly or partly by ores of the metals, preferably those containing the oxides or carbonates, *e.g.*, New Caledonian ores. The ores should be free from sulphur and arsenic, which constituents may be removed by roasting and lixiviation. Ores poor in cobalt and nickel are employed in conjunction with pure oxides, or a mixture of different ores may be used. Examples are given. (*Chem. Abs.*, **11,** 3406 (1917); *Chem. and Ind.*, **36,** 963 (1917).)

Koepp, R., and Co.

MANUFACTURE OF ENAMELS. British Pat. 101,221, Aug. 16, 1916.—Enamels are clouded or rendered opaque by the addition of zirconium borate supersaturated with zirconia, *e.g.*, a product consisting of $ZrO_2 \cdot 2B_2O_3 + 4\ ZrO_2$. The materials are preferably fused with cryolite or other alkali fluoride. By adding KNO_3 or other oxidizing agent, raw ZrO_2 may be employed, *e.g.*, 70 parts raw ZrO_2, 30 H_3BO_3, 20 cryolite, and 50 KNO_3 are thoroughly mixed together and fused, and, after cooling, the product is ground very fine. (*Chem. Abs.*, **11,** 93 (1917); *Chem. and Ind.*, **36,** 291 (1917).)

Kohl, H.

INFLUENCE OF SMALL ADDITIONS OF ELECTROLYTES ON THE STABILITY OF CLAY SUSPENSIONS; USE OF THESE IN THE PURIFICATION OF CLAYS. *Ber. deut. keram. Ges.*, **3,** 64 (1922).—To Zettlitz kaolin, freed from salts by washing, and suspended in H_2O was added 0.1 *N* Na_2CO_3 or 0.1 *N* Na silicate, and the whole well mixed by shaking. Photographs of the suspensions, after 3 weeks, showed that, with increasing amounts of electrolyte, the amount of suspended material increased up to a definite maximum, after which further additions of electrolyte caused clarification. Very small percentages of $CaSO_4$ in the clay reduce the stability of the suspension. Na silicate is more efficient than Na_2CO_3 and an excess of it is less harmful. The presence of soluble or colloidal SiO_2 is unnecessary when the clay contains a protective colloid such as humic acid. Clays containing soluble salts, particularly those of Mg and Ca, are not suitable for purification by the addition of electrolytes unless these salts are first removed or rendered insoluble. Quartz particles are usually too large to remain in suspension, but the smallest may be suspended, the best results being obtained with 0.208% Na_2CO_3 or 0.5% Na_2SiO_3. Hence the finest particles of quartz are electro-negative, and behave like clay. A cataphoresis test showed that these particles pass to the anode, like clay, and cannot be separated from it by osmosis. Feldspar behaves in a similar manner.

Mica, when sufficiently finely divided, behaves like clay. A mixture of 70% of kaolin and 30% of mica, when treated with the optimura proportion of Na_2CO_3, produced a suspension containing 80% of kaolin and 20% of mica, showing that most of the mica is retained in suspension with the clay. A cataphoresis test showed that finely divided mica passed wholly to the anode, precisely like clay, so that the finest particles of mica cannot be separated from clay, either by sedimentation or by electroösmosis. Pyrite can, to a large extent, be separated from clay by elutriation or washing. Extremely minute particles of pyrite which remained in suspension in distilled water for $^1/_2$ day were flocculated by Na_2CO_3 and Na silicate and also by H_2SO_4. A mixture of kaolin and these fine particles of pyrite settled in 2 hrs., and a suspension of kaolin, to which 0.5 g. of pure $FeSO_4$ was added in solution, flocculated and settled in 6 hrs. A cataphoresis test of a mixture of 80 g. of kaolin and 7 g. of pyrite effected no separation. It appears to be impossible to separate the most finely divided pyrite from clay. The occurrence of such finely divided pyrite is, however, improbable; it would rapidly be oxidized to sulphate. Fe_2O_4 when sufficiently finely divided is completely absorbed by the clay suspension, and on electroösmosis it is deposited along with the clay, on the anode. Only relatively coarse particles of SiO_2 mica and Fe compounds can be separated from clay. No electrolyte is necessary for this separation, but its use is convenient, as it facilitates the suspension of the clay, and so makes the so-called purification of clay by electroösmosis, the whole of the "purification" occurs in the preliminary settling tanks. The electric treatment does not effect any further purification. At the same time, the smaller amount of space and H_2O required when an osmosis machine is used (as compared with a filter press) is noteworthy. (*Chem. Abs.*, **16**, 4311 (1922).)

Kohler, Walter J.

MAKING SPECKLED ENAMELED WARE AND THE PRODUCT THEREOF. U. S. Pat. 806,153, Dec. 5, 1905.—The process consists of mixing a comparatively small amount of comminuted Carborundum with dry pulverized enameling material of one color (different from the Carborundum), putting the mixture on the article to be coated with enamel, and then subjecting the article to such heat as fuses the enameling material but less than sufficient to fuse the Carborundum.

Kohler and Co.

MARKING ENAMELED WARE. British Pat. 129,206, Dec. 23, 1918. See U. S. Pat. 1,290,580 of 1919. (*Chem. and Ind.*, **38A**, 177, 579 (1919).)

Kohler, W. J.

MARKING ENAMELED WARE. U. S. Pat. 1,290,580, Jan. 7, 1919.—The article to be marked is provided with a ground coat of binding material; it is then heated to a white heat, a coat of powdered enamel is applied, the article is again heated so as to fuse the first coat of enamel, and while it is hot, a second coating of enamel is applied. Lines of marking enamel of a different color are then applied and the article is reheated so as to fuse the second coating of enamel and form a smooth surface. (*Chem. Abs.*, **13**, 780 (1919); *Chem. and Ind.*, **38A**, 177 (1919).)

Kommanditges, H.

ENAMELS. British Pat. 197,933, May 10, 1923; Chemische Werke vorm. Auerges. m.b.H.—To prevent opaque enamel from bubbling during firing, a portion of the clay which is usually added to the mill is first made incandescent and then added to the other ingredients. One-half of the clay may be so treated, and the process is stated to be particularly applicable when Zr or Ce oxide is present. (*Ceram. Abs.*, **3**, 6 (1924); *Chem. and Ind.*, **43B**, 382 (1924).)

Komerell

ENAMELED COOKING VESSELS. *Gew. Bl. Bayr.*, **19**, 222; *Z. Blechind.*, **16**, 387. (*Rep. der Tech. Lit.*, p. 127 (1885–1887).)

Kondo, Seiji

DEVELOPMENT OF CERAMIC TECHNOLOGY AND SCIENCE IN JAPAN. *Jour. Amer. Ceram. Soc.*, **6**, 212 (1923).—Descriptive article dealing with development of various phases of the work in Japan.

Kralapp, E.

FURNACES FOR PREPARATION OF FRITTED ENAMELS. *Keram. Rundschau*, **20**, 261 (1912).—A calcining pan furnace for the preparation of tin ash and two frit furnaces are described and illustrated. (*Chem. Abs.*, **6**, 3505 (1912).)

Kramer, E.

ELECTRIC ENAMELING OVEN. *Jour. Elec. Western Ind.*, **48**, 114 (1922).—Details of construction and operation of an automatic oven enameling 40 lbs. of metal per kw. hr. (*Ceram. Abs.*, **1**, 169 (1922); *Chem. Abs.*, **16**, 997 (1922).)

***Kraner, Hobart M.**

HYDROGEN-ION CONCENTRATION AND ELECTRICAL CONDUCTIVITY OF CLAY SLIPS. See Fessler, A. H. (this *Bibliography*, p. 119).

Krätzer

ENAMELS AND GLAZES. *Dek. Maler.*, No. 32, p. 26; *Desgl.*, **33**, 30. (*Rep. der Tech. Lit.*, p. 118 (1888–1890).)

Krätzer

ENAMELS AND GLAZES. *Gew. Bl. Wurt*, **39**, 370; *Z. Maschinent*, **4**, 342, 360, 378; *Z. Blechind.*, **14**, 795; *Naturw. U.*, **3**, 673. (*Rep. der Tech. Lit.*, p. 127 (1885–1887).)

Krause, H.

ENAMELS. *Electrochem. Z.*, **20**, 113, 143, 176.—Historical and descriptive review of enamels, their composition, manufacture, and use. (*Chem. Abs.*, **8**, 805 (1914).)

***Krause, H. F.**

BEHAVIOR OF FLUORIDE INGREDIENTS OF GLASSES AND ENAMELS. I. See Agde, G. (this *Bibliography*, p. 2).

BEHAVIOR OF FLUORIDES IN GLASSES AND ENAMELS. II. See Agde, G. (this *Bibliography*, p. 3).

EFFECT OF FLUORIDE ADDITIONS TO GLASSES AND ENAMELS. III. See Agde, G. (this *Bibliography*, p. 2).

Krause, O.

VISCOSITY MEASUREMENT OF CERAMIC BODIES. *Sprechsaal*, **58**, 230 (1925).—K. discusses the advantages and disadvantages of the Fischer Bauer ball viscosimeter. K. obtained good results for plant control work by using a 200-cc. pipette for measuring the viscosity of clays by the flow method which gives comparable results but does not give the actual viscosity of the slip. (*Ceram. Abs.*, **4**, 227 (1925).)

Kraze, Fritz

ZIRCONIUM FLUORIDE GLAZES AND ENAMELS. *Ber. deut. Keram. Ges.*, **3** [3], 157 (1922).—Low-temperature glazes, free from Pb and B, rendered opaque by Zr fluoride, are

particularly suitable for fire clays and other porous bodies low in CaO. Zr compounds do not produce a good opaque white glaze in the absence of fluorides, except at inconveniently high temperatures. The glaze recommended is made from a mixture of Na silicofluoride, cryolite, soda ash, orthoclase, feldspar, quartz, Ba peroxide, and zircon, in proportions corresponding to the following formula: (0.323 Na_2O, 0.412 Na_2F_2, 0.214 K_2O, 0.051 BaO), 0.412 SiF_4, 0.234 Al_2O_3, (3.029SiO_2, 0.184 ZrO_2). In the formula, the maximum permissible proportion of zircon is used; part of this may be replaced by cryolite if desired. In each case, a portion of the kaolin (0.02 mol.) is added after the other materials have been fritted and ground. The fritting must be continued until no more gas is evolved after which the frit is run into a tank, and allowed to cool slowly; it is then mixed with the reserved amount of clay and ground in a ball mill. The glazed ware must be placed in the kiln in such a manner that any vapors evolved may readily escape, or the glaze will be soluble in water. The optimum glazing temperature is cone 05 *a* (1000°). As enamels on Fe, these zircon fluoride glazes are particularly useful, on account of their great elasticity and the rapidity with which they may be fired and cooled. (*Chem. Abs.*, **17**, 2177 (1923).)

Kraze, F.

SALTPETER REPLACEMENT IN THE ENAMEL INDUSTRY. *Keram. Rundschau*, **23**, 5 (1915).—K. suggests BaO_2 as the best substitute, and the use of sodium chloride to remove the iron by forming volatile chlorides. (*Chem. Abs.*, **9**, 3341 (1915).)

Kraze, F.

TECHNIQUE OF IRON ENAMELS APPLIED DRY. *Sprechsaal*, **47**, 535, 545 (1914).—Details of making and applying enamels and the effect of various materials in producing opacity are given. Limits of good enamel composition are given as:

ZnO	0.20–0.00	SiO_2	0.77–0.64
Na_2O	0.74–0.70	B_2O_3	1.14–0.68
K_2O	0.006–0.11	P_2O_5	0.43–0.00
CaO	0.00–0.19	SnO_2	0.34–0.00
Al_2O_3	0.12–0.15	F	0.60–0.86
Sb_2O_3	0.00–0.13		

(*Chem. Abs.*, **9**, 957 (1915).)

Krebs, A. E.

FISHSCALING OF SHEET-IRON ENAMELS. *Ceram. Ind.*, **6**, 41 (1926).—The probable causes of fishscaling are given as: (1) impurities in the iron, (2) impurities in the water, (3) poor clay, (4) improper pickling, (5) overfiring and underfiring of the ground coat, (6) defects in the enamel composition, (7) impurities in the raw materials, and (8) oversmelting. For discussion see this *Bibliography*, p. 57.

Krebs, G.

ENAMELING JEWELRY, ETC. U. S. Pat. 126,308, April 30, 1872.—Process consists in applying the enamel to the articles to be enameled in a dry, powdered state, and then exposing the same to heat until the enamel is partially melted, in such a manner that the enameled surface presents a dull or frozen appearance, producing an entirely different effect from the ordinary bright enameled surfaces, and, furthermore, much time and labor are saved.

Kreger, John M.

FACTORY TESTS FOR FELDSPAR. *Ceramist*, **5**, 260 (1925).—Practical factory tests for feldspar used in the manufacture of sanitary porcelain ware are given. A series of

experiments using graded additions of potters' flint will enable the potter to know something of the free quartz content and the flint-carrying capacity of the feldspar. Photographs of results obtained by K. on such a series, are included.

Kreidl, I.

ENAMELS. British Pat. 245,757, Jan. 10, 1925.—White oxides of metals not ordinarily used as opacifying media for enamels are rendered suitable for this purpose by converting them into colloids in the form of a gel, preferably in a colloid mill. Oxides of Sn or Zr or NaOAc or similar compounds may be added to prevent the colloidal substance from dissolving in the enamel mixture. (*Ceram. Abs.*, **6,** 96 (1927); *Chem. Abs.*, **21,** 310 (1927); *Chem. and Ind.*, **46B,** 332 (1927).)

Kreidl, I.

COMPOSITION FOR RENDERING WHITE ENAMELS OPAQUE. U. S. Pat. 1,101,455. June 23, 1914. (See addition of June 6, 1912, to French Pat. 429,655 of 1910.)—Zirconium compounds, free from silica (*e.g.*, the zirconium oxide) are mixed with an equal weight of silicic acid or a silicate, and heated with the hydroxide or carbonate of an alkali or alkaline-earth metal, with the subsequent removal of the soluble silicates and free alkaline matter. The products are used as opacifying agents in the preparation of white enamels. (*Chem. Abs.*, **8,** 2932 (1914); *Chem. and Ind.*, **31,** 1181 (1912); *ibid.*, **33,** 750 (1914).)

Kreidl, I.

OPAQUE ENAMEL. U. S. Pat. 1,104,679, July 21, 1914.—The enamel contains colloidal zirconium oxide, to render it opaque. (*Chem. Abs.*, **8,** 3106 (1914); *Chem. and Ind.*, **33,** 921 (1914).)

Kreidl, I.

MAKING AN OPAQUE MATERIAL FOR WHITE ENAMELS. U. S. Pat. re-issue 13,791, August 24, 1914.—Natural zirconium silicate is heated with 4 times its weight of sodium hydroxide to 500 to 600°, washed, dried, and heated to a glowing temperature. (Reissue of U. S. Pat. 1,024,405, April 23, 1912; see French Patent 429,665 of 1911); (*Chem. Abs.*, **8,** 3494 (1914); *Chem. and Ind.*, **30,** 1213 (1911); *ibid.*, **33,** 964 (1914).)

Kreidl, I.

WHITE ENAMEL. U. S. Pat. 1,117,197, Nov. 17, 1914.—The opaquing material is formed of zirconium oxide combined with silica and about 3 to 4% of alkali metal. See French Pat. 450,228, Sept. 7, 1912. (*Chem. Abs.*, **9,** 136 (1915); *Chem. and Ind.*, **32,** 488 (1913); *ibid.*, **33,** 1207(1914).)

Kreidl, I.

MATERIAL FOR OPAQUING WHITE ENAMEL. U. S. Pat. 1,123,760, Jan. 5, 1915.—A mixture of caustic alkali or alkali carbonate, zirconium oxide, and silicic acid is heated and the soluble silicates and combined alkali removed from the product by washing with water and dilute acid. (*Chem. Abs.*, **9,** 701 (1915); *Chem. and Ind.*, **34,** 178 (1915).)

Kreidl, I.

OPAQUING MATERIALS FOR ENAMELS, GLASS, ETC. U. S. Pat. 1,128,691, Feb. 16, 1915.—Hydrates of zinc oxide containing 2 to 7% combined alkali and a few per cent of water, varying inversely as the amount of alkali. By using a larger per cent of alkali with less water the same opaquing effect is obtained as with less alkali and more water. (*Chem. Abs.*, **9,** 1103 (1915); *Chem. and Ind.*, **34,** 356 (1915).)

Kreidl, I.

WHITE ENAMEL. U. S. Pat. 1,129,300, Feb. 23, 1915.—The opaquing agent consists of zirconium oxide combined with a small amount of alkali. See addition to French Pat. 438,908 of 1912. (*Chem. Abs.*, **9**, 1103 (1915); *Chem. and Ind.*, **31**, 643 (1912); *ibid.*, **34**, 356 (1915).)

Kreidl, I.

OPAQUING MATERIAL FOR WHITE ENAMELS. U. S. Pat. 1,150,772, Aug. 17, 1915.—Alkaline compound of zirconium or other opaquing metal formed by treating with acid and washing to remove part of the combined alkali, and improve the opaquing effect of the material. See French Pat. 462,587 of 1913. (*Chem. Abs.*, **9**, 2701 (1915); *Chem. and Ind.*, **33**, 314 (1914); *ibid.*, **34**, 963 (1915).)

Kreidl, I.

MANUFACTURE OF OPACIFIERS FOR ENAMELS. German Pat. 422,600, Nov. 29, 1924.—Zircon is decomposed by fusion with alkaline reagents and the product so obtained is treated with hydrofluoric acid to convert the combined and adsorbed silica into silicon fluoride. The amount of silica retained by the zirconia is a function of the temperature of fusion and of the quantity of alkali used in the fusion. (*Chem. and Ind.*, **45B**, 323 (1926).)

Kreidl, I.

MAKING A FILLER FOR WHITE ENAMEL. U. S. Pat. 1,024,405, April, 23, 1912. See French Pat. 429,665, June 8, 1910. (*Chem. Abs.*, **6**, 1666 (1912); *Chem. and Ind.*, **30**, 1213 (1911).)

Kreidl, I.

OPACIFYING MEDIA FOR ENAMELS. British Pat. 24,575, Dec. 29, 1925.—White oxides of metals, not normally used as opacifiers, are rendered suitable by converting them into a gel form in colloid mills. Known opacifying agents are added to prevent the colloidal substance from dissolving in the enamel mixture. (*Ceram. Abs.*, **5**, 385 (1926).)

Kreischer, C. F.

ENAMELING FURNACE. U. S. Pat. 492,405, Feb. 28, 1893.—In a muffle oven the combination with the bottom tiles of the side walls of the muffle made of hollow brick, each provided with two square openings and having the center partition double the size of an end partition.

Kretzer, H.

MANUFACTURE OF CLOUDED GLASSES, ENAMELS, ETC., AND OF CLOUDING AGENTS CARRYING OUT THIS PROCESS. French Pat. 444,440, May 30, 1912; British Pat. 12,749, May 30, 1912.—The clouding agents employed are oxidized compounds of antimony or tin with barium, strontium, calcium, magnesium, or aluminum. The compounds are made by bringing together at a red heat those salts of the metals, which after heating, will leave a residue of their oxides, while the acid contained in them is volatilized. The process may be carried out by heating together only the salts of the kind just described of one of the metals with those compounds of the other metal which when heated to redness leave a residue of their oxidized compounds. The process may also be carried out by heating compounds of antimony and tin with compounds of barium, strontium, calcium, magnesium, or aluminum and adding acids which after heating are volatilized and leave a residue of the metallic oxides. (*Chem. and Ind.*, **31**, 1129 (1912).)

Kretzer, H.

OPACIFYING ENAMELS AND GLAZES. German Pat. 416,397, May 16, 1915.—The vitreous constituent of enamels and glazes is ground with insoluble fluorides of metals which form white oxides and with silica or acid silicates of metals the oxides of which are white. Titania or acid titanates may also be added. Subsequent strong ignition of the mixture improves the covering power. (*Chem. and Ind.*, **45B**, 129 (1926).)

Kretzer, H.

CLOUDED ENAMELS AND GLASSES. Swiss Pat. 73,471, May 1, 1917.—Silicon compounds of acid character are added to the enamel mass, after melting and while grinding, to impart a cloudy effect to the product. (*Chem. Abs.*, **11**, 3406 (1917).)

Kretzer, H., and Cappel, A.

OPAQUE ENAMELS. U. S. Pat. 1,239,112, Sept. 4, 1917.—The opacifying agent, *e. g.*, a compound of Zr, Ti, Si, Al, Zn, or alkaline earth metals, is added to the other ingredients of the enamel after they have been at least partially ground in a wet mill, together with substances which precipitate colloids, such as ammonium chloride, magnesium sulphate, or chloride, or sodium sulphate, or precipitating colloids. A better opacifying effect is secured by adding the opacifier after grinding has been partially completed. (*Chem. Abs.*, **11**, 3407 (1917); *Chem. and Ind.*, **36**, 1130 (1917).)

Krupsay

CONCERNING THE PLASTICITY OF CLAY. *Tonind.-Ztg.*, **32**, 1289 (1908).

Krynitsky, A. I.

ENAMELING DEFECTS DUE TO CAST IRON. *Jour. Amer. Ceram. Soc.*, **8**, 618 (1925).—A discussion of Malinovszky's paper on enameling defects due to cast iron. Problems are suggested for further investigation on the subject. If conclusions are based on these observations, it could be stated that the quantity of graphite and size of the graphite flakes are of greater importance than the amount of combined carbon in the irons for enameling purposes. K. does not believe that there were enough data for Malinovszky's conclusions. The above paragraph shows what he might conclude from the few tests that K. ran. Blistering appears to be a complex phenomenon and there are evidently several factors which might exercise great influence on it. (*Chem. Abs.*, **19**, 3575 (1925); *Chem. and Ind.*, **44B**, 922 (1925).)

Kühn, C.

INFLUENCE OF NUMBER AND SIZE OF PARTICLES ON COVERING POWER. *Farben. Ztg.*, **31**, 1131 (1926).—Opacity is proportional to number of particles per unit volume, the relative dimensions of the particles not affecting opacity within certain limits, but the rate of increase of opacity with increase in the number of particles per unit volume is more rapid in the case of the finer particles. (*Ceram. Abs.*, **5**, 268 (1926); *Chem. and Ind.*, **45B**, 287 (1926).)

Kursh, F.

ENAMELING JEWELRY. U. S. Pat. 227,021, April 27, 1880.—The process of enameling, consisting in applying particles of dry enamel with fluid ground to a piece of jewelry or other article, subjecting the same to a fusing heat, and afterward grinding the resultant surface.

Kutscher, G.

PROTECTION OF IRON AT RED HEATS WITH A METAL COATING. *Keram. Rundschau*, **33**, 55 (1925).—The destruction of iron at red heats is considerable, due to the oxidation

of the same. Molten Al is sprayed on iron after it has been sandblasted and the aluminum unites with the Fe. In the subsequent firing the Al is oxidized to Al_2O_3 which is very refractory and thus the Fe is protected with a coating of refractory Al_2O_3. The spraying of grate bars with Al in this manner has greatly prolonged their life. Metal spraying is used for many other purposes. It is claimed that a metal spray may be put on combustible materials as paper, wood, and cloth, as well as metal, stone, unglazed porcelain, plaster, etc. The metal to be sprayed on other materials is fed into the spray gun as a wire. The wire is melted and sprayed by means of gas and compressed air of 2.2 atmospheres. The capacity of one of these spray guns varies with the fusibility of the metal to be sprayed varying from 6 kg. for easy melting metals to 0.8 kg. for metals which melt with difficulty. A thickness of $^1/_{30}$ to $^1/_{20}$ mm. is usually sprayed on grate bars while ware coated to make it resistant to chemicals is now being coated with a thickness of $^2/_{10}$ to $^5/_{10}$ mm. It is important that the metal surface to be sprayed be rough and freshly sandblasted as the metal will not stick as easily to smooth surfaces which have not been sandblasted. The use of acids to clean the surface is not necessary. (*Ceram. Abs.*, **4**, 156 (1925).)

Labad, Alberto

ENAMELS ON GLASS. *Quim. e ind.*, **4**, 118 (1927).—A good method of decorating glass consists of gluing with collodion on the glass a lithochrome negative made on tissue paper with heat-resistant colors and covering it with a suitable enamel. The following enamels are easily fusible, give brilliant colors, and permit the incorporation of coloring metal oxides: Pb_3O_4 76, B_2O_3 13, $Na_2B_4O_7$ 11%, or, in order to prevent cracking on glasses with a high dilatation coefficient: Pb_3O_4 68, B_2O_3 11.7, $Na_2B_4O_7$ 10.8, Na_2CO_3 9.5%. Glass decorated with these enamels has not changed during 2 years' standing. Enamels containing SiO_2 were unsatisfactory because of high melting point and dull colors. (*Ceram. Abs.*, **6**, 569 (1927).)

Ladd, James B.

METHOD OF ENAMELING CENTRIFUGALLY CAST PIPE. U. S. Pat. 1,521,634, Jan. 6, 1925.—The method of applying enamel to the inside of centrifugally cast pipe which consists in floating the enamel on the surface of the molten metal in the container through which the metal is introduced into the rotating mold and pouring the metal and enamel simultaneously into the mold. (*Ceram. Abs.*, **4**, 62 (1925); *Chem. Abs.*, **19**, 713 (1925).)

Lai Chi-Fang

SHEET-STEEL COOKING WARE WHITE ENAMELS ECONOMICALLY SUITABLE FOR USE IN CHINA. *Jour. Amer. Ceram. Soc.*, **10**, 150 (1927).—The research was carried on to develop data on sheet-steel enamels which would be good enough and cheap enough to use in China. Substitutes for tin oxide were tested. An efficient and cheaply constructed kerosene fired enameling furnace was designed and built. Little could be gained by work on the ground coats. Sodium antimonate and calcined alumina yielded the cheapest enamels with quality almost equal to enamels made with tin oxide. Zirconium oxide yielded the best results when tested with acids. Cryolite could be reduced to the minimum and with benefit to the resulting product. High feldspar enamels proved to be most satisfactory. High zinc oxide content greatly increased the gloss but lowered the opacity. Calcined alumina failed when used alone. (*Ceram. Abs.*, **6**, 168, 212 (1927); *Fuels and Fur.*, **5**, 325 (1927); *Chem. Abs.*, **21**, 1876 (1927); *Chem. and Ind.*, **46B**, 779 (1927).)

Laissus, J.

CEMENTATION OF IRON BY TUNGSTEN, MOLYBDENUM, AND TANTALUM. *Compt. rend.*, **182,** 1152 (1926).—Cementation of an iron containing 0.15% carbon by the above elements was studied between 800 to 1200°C. Micrographical examination showed the existence in the interior of a solid solution bounded by a brilliant external layer, the thickness of which increases with rise of temperature and duration of treatment. Copper and brass similarly treated gave cemented layers which increase in thickness with rise of temperature. The ferro-molybdenum used contained 71.85% molybdenum, 1.86% carbon, and the ferro-tantalum contained 29.26% tantalum, 1.96% silicon, 1.00% carbon. (*Ceram. Abs.*, **5,** 299 (1926); *Chem. and Ind.*, **45B,** 545 (1926).)

Lake, H. H.

IMPROVEMENTS RELATING TO ENAMELING OF ARTICLES OF COPPER. British Pat. 11,979, July 27, 1889.—Copper cooking utensils, etc., are enameled internally with a composition consisting of 4 parts of feldspar, 3 flint, 5 borax, and 2 cryolite. (*Chem. and Ind.*, **9,** 807 (1890).)

Lambert, W., and Mead, A. A.

ENAMELING INTERIOR OF PIPES. U. S. Pat. 1,577,531, Mar. 23, 1926.—A hot pipe is rotated about a nozzle which is passed within the pipe to supply reducing gas and enamel. (*Chem. Abs.*, **20,** 1701 (1926).)

Lambert, W., Mead, A. A., and Stone, J., and Co.

ENAMELING OR GLAZING METAL ARTICLES. British Pat. 243,033, May 20, 1924.—In hot enameling metal tubes or other metal articles, while they retain sufficient heat from a previous treatment to effect complete vitrification of the enamel, a reducing or neutral agent is delivered to the metal simultaneously with the coating material to prevent oxide formation and to reduce oxide already present. (*Chem. Abs.*, **20,** 3790 (1926).)

Landau, Kreidl, Heller, and Co.

WHITE ENAMEL. Austrian Pat. 4,677,009, June 13, 1909.—In the manufacture of white enamel, the products (solid solutions obtained from light-obscuring oxides and alkaline earths) are employed. (*Chem. Abs.*, **7,** 3209 (1913).)

Landau, Kreidl, Heller, and Co.

WHITE ENAMELS. Austrian Pat. 4691/10, June 8, 1910.—In the production of white enamels, employing as the opaque white material a voluminous powder obtained from zirconium silicate by splitting off only a portion of the SiO_2 or a substance of like character produced synthetically. (*Chem. Abs.*, **6,** 2303 (1912).)

Landau, Kreidl, Heller, and Co.

WHITE ENAMEL. Austrian Pat. 4963/11 June 8, 1911 (addition to 54,055).—In the manufacture of white enamel with the aid of zirconium compounds, the mixture is heated in the presence of hydroxides or carbonates of the alkalis or alkaline earths, and the resulting mass is freed from the silicates formed and the combined alkali is removed. (*Chem. Abs.*, **7,** 2845 (1913).)

Landau, Kreidl, Heller, and Co.

CLOUDING AGENT FOR WHITE ENAMEL. British Pat. 11,754, May 17, 1912.—Addition to British Pat. 10,418, April 29, 1911. A clouding agent for white enamels, etc., consists of a silica-containing zirconium compound, free from combined alkali and containing a smaller proportion of SiO_2 than present in zircon, made by heating a mix-

ture of zirconium compound containing no SiO_2 with SiO_2 or compounds thereof in the presence of an alkali or earthy alkali and then removing the combined alkali. In an example, ZrO_2 and SiO_2 are mixed in molecular proportions and, after adding an equal weight of caustic alkali, the whole is heated to a temperature above red heat. The reaction product is freed from soluble silicates by treatment with water and the combined alkali is removed by treatment with a weak acid, and after drying or igniting the residue, a voluminous siliceous product remains. The proportions of SiO_2 and ZrO_2 may be varied and a larger proportion of alkali is used when the mixture is heated to a temperature below red heat. (*Chem. Abs.*, **7,** 3649 (1913); *Chem. and Ind.*, **31,** 1181 (1912).)

Landau, Kreidl, Heller, and Co.

CLOUDING AGENTS FOR WHITE ENAMELS. British Pat. 16,787, July 18, 1912.—Zircon is partially disintegrated by heating with sodium hydroxide or carbonate and the soluble silicates and surplus alkali removed with water. The combined alkali is partly removed by treating the mass with ammonium or metallic salts and the product then heated until the water of hydration is removed. (*Chem. Abs.*, **8,** 410 (1914); *Chem. and Ind.*, **32,** 828 (1913).)

Landau, Kreidl, Heller, and Co.

OPAQUING AGENTS FOR WHITE ENAMELS. British Pat. 1136, Jan. 15, 1912.—A hydrated compound of a suitable metal such as Sn, Ti, Zr, Al, or the like containing a small quantity of alkali, or having part of the water of hydration removed. The hydrated compound may also contain SiO_2. Hydrated ZrO_2 may be obtained by wholly or partially removing the combined alkali from a zirconate produced, *e.g.*, by completely opening up zircon by heating with an alkaline flux or by heating ZrO_2 with an alkaline flux, this removal being effected by means of water, a solution of a weak acid, or salt of a weak base. The hydrated oxide is subsequently dried at such a temperature that none, or only part, of the combined water is driven off. Hydrated zirconium compounds containing SiO_2 may be prepared by removing the combined alkali in a similar manner from zircon partially opened up by heating with an alkaline flux. Other hydrated metal compounds suitable for opaquing purposes may be prepared similarly. (*Chem. Abs.*, **7,** 2460 (1913); *Chem. and Ind.*, **32,** 488 (1913).)

Landau, Kreidl, Heller, and Co.

CLOUDING WHITE ENAMELS. British Pat. 19,849, Aug. 30, 1912.—In the manufacture of hydrated or anhydrous metal compounds, containing alkali for clouding white enamels, etc., as described in 1136 (in 1912) and 16,787 (in 1912), using 2 to 7% alkali, the amount being preferably between 3 and 4%. (*Chem. Abs.*, **8,** 562 (1914); *Chem. and Ind.*, **31,** 643 (1912); *ibid.*, **32,** 753 (1913).)

Landau, Kreidl, Heller, and Co.

WHITE ENAMELS. British Pat. 29,382, Dec. 20, 1912. (Addition to British Pat. 1136, Jan. 15, 1912).—The amount of water of hydration contained in the hydrated oxide used as the opaquing agent is varied in inverse proportion to the per cent of alkali used. From 2 to 7% alkali may be used with hydrate water varying from 15 to 2%. The invention is not applicable to tin compounds. (*Chem. Abs.*, **8,** 2046 (1914); *Chem. and Ind.*, **33,** 137 (1914).)

Landau, Kreidl, Heller, and Co.

OPAQUING AGENTS FOR WHITE ENAMELS. British Pat. 17,998, Aug. 7, 1913.—Highly basic compounds or complexes of aluminum, tin, titanium, or zirconium, containing a small proportion of the radicals not refractory to heat. According to one

process, the opaquing agents are obtained by treating alkali compounds of the above metals with weak acids such as organic acids, part of the alkali salt of the acid being allowed to remain in the reaction product. Another process consists in heating salts of the above metals, to expel part of the acid radicals. (*Chem. Abs.*, **9**, 363 (1915); *Chem. and Ind.*, **33**, 921 (1914).)

Landau, Kreidl, Heller, and Co.

MANUFACTURE OF WHITE ENAMELS. French Pat. 429,665, May 12, 1911; (first addition June 6, 1912); see British Pat. 10,418, April 29, 1911.—Oxide of zirconium is too expensive to use for rendering enamels opaque, and the silicate has insufficient covering power. But if a portion of the silica, either of the natural or of the artificial silicate, be removed by warming with alkali carbonates or hydroxides, the resulting product is said to yield a voluminous powder which is very effective for rendering enamels opaque. (*Chem. and Ind.*, **30**, 1213 (1911); *ibid.*, **31**, 1181 (1912).)

Landau, Kreidl, Heller, and Co.

WHITE ENAMEL. French Pat. 438,908, Jan. 11, 1912; French Pat. 450,228, Sept. 7, 1912.—*French Patent 438,908:* Metal hydroxides have proved in general a better enamel covering than the oxides (*e.g.*, the hydroxides of Sn, Ti, Zr, Al). The alkali content is reduced to 3 or 4%. *French Patent 450,228:* The zirconates and Zr-SiO_2 compounds obtained from the partial or complete disintegration of zircon by alkalis are reduced in alkali content so that the covering agent retains 2 to 7% After the washing with water has removed the soluble silicates and the alkali excess, the bound alkali is eliminated by ammonium salts or tin or aluminum salts and the residue is dried. (*Chem. Abs.*, **7**, 3210 (1913); *Chem. and Ind.*, **31**, 643 (1912); *ibid.*, **32**, 388 (1913).)

Landau, Kreidl, Heller, and Co.

WHITE ENAMEL. French addition to Patent 438,908, Jan. 18, 1913.—Each hydrate unit gives its highest effect with a certain alkali amount which must be ascertained empirically. The covering power of the mass is dependent not only upon the content of alkali, but also upon that of combined water of hydration. With a higher alkali content the same covering power is secured as with a lower alkali content, if the hydrate water is decreased. (*Chem. Abs.*, **8**, 411 (1914).)

Landau, Kreidl, Heller, and Co.

COVERING MASSES FOR WHITE ENAMELS. French Pat. 456,335, April 4, 1913.—Oxides or silicates of tin, zirconium, and other bases used as materials for producing opacity are compounded with phosphoric acid or other analogous acid, the latter being present in very small molecular quantities. The effect of these products can be greatly augmented by combination with water of hydration or with alkalis or alkaline earths. With a decreasing content of phosphoric acid, the hydration or alkali content should be increased. If both combined water and alkali be present, it is best to reduce phosphoric acid and alkali, and increase hydration. (*Chem. Abs.*, **8**, 2047 (1914); *Chem. and Ind.*, **32**, 945 (1913).)

Landau, Kreidl, Heller, and Co.

WHITE, PARTICULARLY ZIRCON, ENAMELS. French Pat. 462,587, Sept. 16, 1913; German Pat. 286,038, Oct. 25, 1912.—In the manufacture of a vehicle for zircon or other white enamel, the elimination of alkali is effected by acids of weak electrolytic dissociation, such as organic acids or their salts, and the elimination of acid is effected by heating, so that an optimum amount of the salt remains. The presence of acids or salts increases the covering power in that the colloidal state of the covering agent is protected

thereby. (*Chem. Abs.*, **8**, 3106 (1914); *ibid.*, **10**, 1086 (1916); *Chem. and Ind.*, **33**, 314 (1914).)

Landau, Kreidl, Heller, and Co.

WHITE ENAMEL. French Pat. 463,623, Oct. 14, 1913.—In the manufacture of white enamel, oxides and silicates are reduced in a state of very fine division, and then treated with water containing acid or alkali. (*Chem. Abs.*, **8**, 2788 (1914); *Chem. and Ind.*, **33**, 355 (1914).)

Landau, Kreidl, Heller, and Co.

WHITE ENAMELS. German Pat. 274,860, June 11, 1910.—Manufacturing white enamels with the aid of zirconium compounds. (*Chem. Abs.*, **8**, 3107 (1914).)

Landau, Kreidl, Heller, and Co.

WHITE ENAMELS. German Pat. 283,504, June 23, 1911. (Addition to German Pat. 274,860.) (*Chem. Abs.*, **8**, 3107 (1914); *ibid.*, **9**, 2579 (1915).)

Landau, Kreidl, Heller, and Co.

WHITE ENAMEL WITH METAL HYDROXIDES AS CLOUDING AGENTS. German Pat. 289,102, Oct. 3, 1911. (*Chem. Abs.*, **10**, 2512 (1916).)

Landau, Kreidl, Heller, and Co.

WHITE ENAMEL WITH USE OF METAL COMPOUNDS IN HYDRATE FORM AS CLOUDING AGENT. German Pat. 294,202, May 7, 1912.—Alkali zirconium compounds in hydrous form are employed. The preferred alkali content lies between 2 and 7%. Experiments have shown that the water content is dependent upon the alkali content, in that with a lower alkali content larger amounts of combined water must be present. Consequently, in using the hydrated alkali zirconium compounds the water is either left in its entirety or only partially removed, according to the alkali content. (*Chem. Abs.*, **12**, 414 (1918).)

Landau, Kreidl, Heller, and Co.

IRON ENAMELS. German Pat. 282,348, Aug. 10, 1912.—Method of directly enameling iron in white. The practice has been to apply first to the iron a ground enamel (clear-colored glass) and then a surface coat (turbid glass), the adhesion of the enamel being effected by the content of CoO or NiO. In order directly to enamel iron in white, a substitute for CoO and NiO (which color the enamel) has been found in the compounds of the elements of the cæsium group, especially cæsium oxide, alone or in admixture, or in combination with other compounds, especially of the rare earths. These compounds also impart adhesive properties to the enamel without coloring it. (*Chem. Abs.*, **9**, 2301 (1915).)

Landau, Kreidl, Heller, and Co.

ALKALI CONTAINING CLOUDING AGENT FOR WHITE ENAMELS. German Pat. 283,792, Aug. 24, 1912.—Metal compounds, other than those of tin, which are suitable for the purpose are used. (*Chem. Abs.*, **10**, 262 (1916).)

Landau, Kreidl, Heller, and Co.

WHITE ENAMELS. Swiss Pat. 62,594, July 8, 1912.—Alkali containing hydroxides of the known metal compounds, used heretofore as obscuring agents, are here employed for that purpose. (*Chem. Abs.*, **8**, 2236 (1914).)

Landau, Kreidl, Heller, and Co.

MANUFACTURE OF WHITE ENAMELS. *Céramique*, **16**, 9 (1913).—Metals utilized as opacifying agents give excellent results in the form of their hydrates. A fixed alkali content increases the opacifying effect. For the hydrate of zirconium silicate an alkali content of from 3 to 4% gives the maximum effect. (*Chem. Abs.*, **7**, 1961 (1913).)

Landau, Kreidl, Heller, and Co.

WHITE ENAMELS OF A ZIRCON BASE. *Céramique*, **16**, 61 (1913).—Directions for making partly hydrated zirconium silicate from zircona. (See also *Céramique*, **14**, 204 (1911); *C. A.*, **6**, 1665 (1912); *Chem. Abs.*, **7**, 2671 (1913).)

Landau, Kreidl, Heller, and Co.

WHITE ENAMELS AND OPACIFIERS FOR WHITE ENAMELS. *Céramique*, **16**, 238 (1913).—The opacifying effect of the metallic oxides of Sn, Zr, Ti, and Al, or of silicic acid compounds utilizable for white enamels are influenced by combination with small amounts of H_3PO_4. Combining water of hydration and alkali or alkaline earths to the above phosphates further favorably influences the opacifying effect. As the water of hydration content is lowered the H_3PO_4 content should be increased and as the alkali content is increased the H_3PO_4 content should be diminished. (*Chem. Abs.*, **8**, 224 (1914).)

Landau, Kreidl, Heller, and Co.

WHITE ENAMELS OF A ZIRCON BASE. *Céramique*, **17**, 52 (1914).—Sulphates, nitrates, or salts of organic acids can be used with the metallic oxides, which produce opacifying effects. Alkali can be freed from opacifiers by reaction with acids and acids can be eliminated by reaction with alkali or by heating to incandescence. It is not advantageous to eliminate all the acid content for a certain small proportion which must be determined by experiment gives a maximum covering ability. The effect of salts or acids appears to depend on the colloidal character of the product. Acids or salts possessing weak electrolytic dissociation are particularly appropriate for opacifying agents, for example organic acids. (*Chem. Abs.*, **8**, 2233 (1914).)

Landau, Kreidl, Heller, and Co., Ver. Chem. Fab.

ENAMEL CLOUDING AGENT. Swedish Pat. 42,530, May 16, 1917.—Zirconium or like compounds with an alkali content of 2 to 7% are used as the clouding agents. (*Chem. Abs.*, **11**, 2724 (1917).)

Landau, Kreidl, Heller, and Co., Ver. Chem. Fab.

OPACIFYING ENAMELS. Austrian Pat. 102,118, May 13, 1923.—To prevent an enamel bubbling when overfired a quantity of anhydrous material rich in alumina, *e. g.*, feldspar, clay, or kaolin, which has previously been heated above 1000°, is added to the opacifier during grinding, in addition to the usual quantity of clay. (*Chem. and Ind.*, **45B**, 542 (1926).)

Landau et Cie., and Rosenzweig, C.

WHITE ENAMEL. British Pat. 10,418; April 29, 1911; *Céramique*, **14**, 204 (1911).—A part of the silicate of either the natural or artificial silicate of zirconium is removed by warming with alkali carbonate or hydroxide, which product is very suitable for rendering enamels opaque. To one part by weight of the zirconium silicate, four of NaOH are added, and the mass is heated 500 to 600°. The resulting mass is treated with water or weak acid, to remove all soluble compounds, and the solid residue consisting of a voluminous powder is dried and ignited if necessary. A complete separation of the

SiO_2 does not take place. (*Chem. Abs.*, **6**, 2986 (1912); (*Chem. and Ind.*, **30**, 1386 (1911).)

Landau et Cie., and Rosenzweig, C.

WHITE ENAMEL OF GREAT COVERING POWER. *Céramique*, **11**, 100 (1908).—French Pat. 389,483, Apr. 22, 1908.—Silicates of zirconium and beryllium are used in place of tin, etc. They are more refractory, more resistant to acids and are cheaper. (*Chem. Abs.*, **3**, 364 (1909); *ibid.*, **4**, 2720 (1910); *Chem. and Ind.*, **27**, 983 (1908).)

Landau et Cie., and Rosenzweig, C.

WHITE ENAMEL. French Pat. 417,078, June 13, 1910.—A substitute for tin oxide is prepared by heating zirconium and calcium nitrates in the proportions necessary to give 70% zirconium and 30% calcium. (*Chem. and Ind.*, **29**, 1383 (1910).)

Landau, Verein Chem. Fabrik.

WHITE ENAMELING. Swedish Pat. 41,858, Jan. 10, 1917.—The clouding agent is an anhydrous zirconium compound, poor in alkali which is treated with salts of metals whose hydroxides or oxides themselves produce clouding effects. (*Chem. Abs.*, **11**, 1735 (1917).)

Landrum, R. D.

NECESSITY FOR OPERATING STANDARDS AND PROCEDURE CONTROL IN THE ENAMELING INDUSTRY. *Bull. Amer. Ceram. Soc.*, **6**, 121 (1927).—A thorough discussion of all the various items in the enamel industry which must be checked as to operating standards and procedure control. These include uniformity in gage of the iron, composition of the iron, design of the black shape, annealing, dies, lubricant, condition of shapes, preparation for enameling in cleaning of the ware, extent of pickling, specifications as to composition and fineness of raw materials for enamel frit, storage of raw materials, weighing and mixing the batch, smelting, quenching, storage of enamel frit, milling of the enamel, storage and aging of the wet enamel, preparation of the enamel for application, drying, firing, and inspection. (*Ceram. Abs.*, **6**, 265 (1927); *Chem. Abs.*, **21**, 2774 (1927).)

Landrum, R. D.

RAW MATERIALS FOR ENAMELS. *8th Int. Cong. App. Chem.*, Vol. 25, 317 (1912).—Review of the function of various raw ingredients of enamel.

Landrum, R. D.

ENAMELS FOR SHEET STEEL. *Ind. Eng. Chem.*, **4**, 561 (1912); *Chem. Eng.*, **16**, 141 (1912).—Description of sheet-iron enameling practice. Sample calculations for molecular formula are given. (*Chem. Abs.*, **6**, 2985 (1912).)

Landrum, R. D.

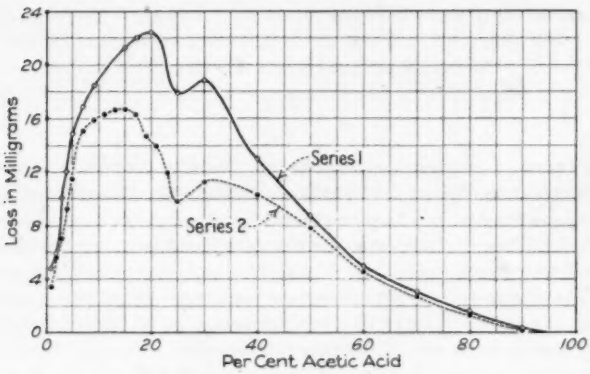
METHODS OF ANALYSIS FOR ENAMEL AND ENAMEL RAW MATERIALS. *Trans. Amer. Ceram. Soc.*, **12**, 144 (1910).—*Part I:* This article gives complete directions for analytical procedure. The determination of F, SiO_2, Fe, Al, Mn, Ca, Mg, alkalis, Sb, Sn, B, Pb, P_2O_5 is made. *Part II:* Analysis of enamel raw materials: borax, sand, flint, quartz, clays and silicates, oxide of tin, pyrolusite, soda ash, pearl ash, saltpeter, and Chili saltpeter, cryolite, fluorspar, antimony oxide, cobalt oxide, sheet steel. (*Chem. Abs.*, **5**, 258 (1911); *Glasind.*, No. 26, 27, 28(1910); *Chem. and Ind.*, **29**, 1310 (1910).)

Landrum, R. D.

RESISTANCE OF SHEET-STEEL ENAMELS TO SOLUTION BY ACETIC ACID OF VARIOUS STRENGTHS. *Trans. Amer. Ceram. Soc.*, **13**, 494 (1911).—*Series I:* Gray enamel mottled with brown

Soft Gray Enamel			Soft Dark Enamel for Spray		
0.667 Na_2O		1.065 SiO_2	0.430 Na_2O		1.700 SiO_2
0.108 K_2O		0.402 B_2O_3	0.083 K_2O		0.430 B_2O_3
0.083 CaO	0.272 Al_2O_3	0.532 F_2	0.200 CaO	0.114 Al_2O_3	0.178 F_2
0.057 MgO			0.045 MgO		
0.025 ZnO			0.056 CuO		
			0.010 CoO		
			0.176 MnO		
Milled with 7% clay			Milled with 7% clay		

Nineteen miniature wash basins, 8.5 cm. in diameter and 2 cm. deep; slushed and fired in a dark-colored ground coat and then dipped into the gray slush enamel; when the excess was shaken off, a light spray of the dark-colored enamel was flipped on with a brush. Dishes were then dried and fired to cone 09 in a muffle furnace, cooled, and then weighed; 25 cc. of 1, 2, and 3% (etc.) acetic acid were added, the dishes placed on a hot plate, evaporated to dryness, baked dry for 15 minutes after apparent dryness, residue washed out, dishes scrubbed lightly with finger, rinsed with distilled water, dried, cooled, and loss in weight noted. *Series II:* Definite molecular formula cannot be given. *Tests:* Same as for Series I. Maximum effect was produced with about 20% acid. Highly concentrated acid solutions have very little action on the enamels. Discussion by H. F. Staley. (*Chem. Abs.*, **5**, 3886 (1911); *Chem. and Ind.*, **30**, 1386 (1911).)



Landrum, Robert D.

COMPARISON OF TEN WHITE ENAMELS FOR SHEET STEEL. *Trans. Amer. Ceram. Soc.*, **14**, 489 (1912).—All enamels smelted at 1050 to 1200°C for from 12 to 25 min.

TABLE I. BATCH COMPOSITIONS

Enamel No.	1	2	3	4	5	6	7	8	9	10
Feldspar	38.6	..	22.0	23.5	35.3	32.0	39.0	38.4	17.7	45.7
Borax	15.4	22.9	30.0	16.2	16.8	26.0	15.0	27.8	20.5	32.0
Quartz	19.0	29.7	17.5	31.4	20.5	8.0	19.0	1.3	35.3	..
Cryolite	11.7	..	..	15.7	12.0	5.0	12.0	..	19.4	..
Soda	..	11.7	13.5	9.3	..	9.0	..	11.3	1.8	11.4
Fluorspar	1.3	..	..	..	2.0	6.0	1.0	5.3	..	..
Calcite	6.5	..	..	..	7.0	..	7.0	..	..	..
Saltpeter	6.5	8.0	2.0	3.1	6.4	3.0	6.0	2.0	1.8	1.7
Magnesite	1.0	..	..	..	..	..	1.0	..	..	..
Magnesia	..	3.7	..	0.8	..	..	..	..	3.5	..
Tin oxide	..	24.0	15.0	..	..	11.0	..	13.9	..	9.2

TABLE II. MOLECULAR FORMULAS

Enamel No.	1	2	3	4	5	6	7	8	9	10
Na_2O	0.497	0.563	0.894	0.834	0.504	0.648	0.500	0.661	0.670	0.841
K_2O	0.186	0.131	0.097	0.098	0.176	0.109	0.179	0.111	0.062	0.142
CaO	0.278	...	0.009	0.007	0.320	0.243	0.282	0.228	0.005	0.017
MgO	0.039	0.306	...	0.061	...	...	0.039	...	0.263	...
Al_2O_3	0.299	...	0.147	0.249	0.281	0.198	0.303	0.203	0.228	0.283
SiO_2	2.513	1.636	2.217	2.571	2.447	1.558	2.525	1.509	2.406	2.013
B_2O_3	0.262	0.396	0.632	0.272	0.284	0.415	0.255	0.463	0.323	0.625
F_2	0.599	...	...	0.721	0.636	0.452	0.598	0.215	0.834	...
SnO_2	...	0.525	0.399	...	...	0.222	...	0.293	...	0.227

(1) TABLE III. RESULTS

Enamel No.		1	2	3	4	5	6	7	8	9	10
ORb		3.1	4.5	4.4	3.4	3.1	2.7	3.0	2.7	3.4	3.2
ORa		6.7	...	6.8	6.8	6.6	5.0	6.7	5.0	6.5	6.8
SiO_2/B_2O_3		9.6	4.1	3.5	9.5	8.6	3.8	9.9	3.3	7.4	3.2
Milling (%)	SnO_2	12	2.1		6.67	11.76	93		7.87		
	SiO_2		4.3								
	Clay	7	8	10	4.44	5.88	7	11.1	4.5	10	6.4
(1) Loss in smelting (%)		17.34	19.89	21.08	16.61	17.86	20.71	17.09	20.87	15.48	21.33
Cost/100 lbs. ($)		6.70	15.07	9.81	5.03	6.67	11.10	2.17	12.08	2.87	7.01
Opacity		4th	2nd	7th	5th	3rd	1st	9th	6th	8th	10th
Acid loss		5th	1st	2nd	3rd	4th	8th	9th	10th	7th	6th
		1.01 mg.	0.0 mg.	0.16 mg.	3.3 mg.	8.4 mg.	19.0 mg.	20.4 mg.	35.3 mg.	15.9 mg.	11.9 mg.
Adhesion under rapid expansion and contraction		2nd	1st	3rd	10th	6th	7th	9th	4th	8th	5th
(2) Adhesion under impact		5th	3rd	9th	6th	2nd	8th	4th	1st	10th	7th
		1.07 g.	1.02 g.	1.31 g.	1.07 g.	1.0 g.	1.13 g.	1.06 g.	0.58 g.	1.42 g.	1.09 g.
Adhesion average		3rd	1st	4th	9th	5th	7th	8th	2nd	10th	6th
Final rating		2nd	1st	4th	5th	3rd	6th	9th	8th	10th	7th

(1) All enamels smelted at 1050 to 1200°C from 12 to 25 minutes. All millings include 1/4% MgO.

(2) Hammer weighing 5 lbs. and falling 20 1/4 in. used in impact test. 20% acetic acid used in acid test.

All millings include 1/4% MgO. Hammer weighing 5 lbs. and falling 20 1/4 inches used in impact test; 20% acetic acid used in acid test. (Discussion by Mr. Rankin, H. F. Staley, and R. C. Purdy.) (*Chem. Abs.*, **7**, 230 (1913); *Chem. and Ind.*, **31**, 1129 (1912).)

Landrum, R. D.

NOTE ON CALCIUM OXIDE GIVING WEAK GLASSES. *Trans. Amer. Ceram. Soc.*, **14**, 542 (1912).—An enamel can be softened with cryolite without making it brittle. This will soften an enamel without seeming to change its coefficient of expansion and without making it unsuitable in practice. (Discussion by H. F. Staley, *Trans. Amer. Ceram. Soc.*, **14**, 516 (1912).)

Landrum, R. D.

NECESSITY OF COBALT OXIDE IN GROUND-COAT ENAMELS FOR SHEET STEEL. *Trans. Amer. Ceram. Soc.*, **14**, 756 (1912).—I. Excellent indicator which will inform the burner exactly the point at which his charge of ware is correctly fired. (Color change of blue to green). II. Promotes adhesion. (Article gives data and illustrations of denting of ware with ground coats with and without cobalt oxide.)

Ground coat No. 1 (batch mix)	Per cent		Graphic formula
Feldspar	36.34	0.642 Na_2O	
Borax	35.64	0.080 K_2O	
Quartz	14.38	0.243 CaO	0.204 Al_2O_3 { 2.256 SiO_2
Soda	7.42	0.025 MnO	0.629 B_2O_3
Fluorspar	5.34	0.010 CoO	0.231 F_2
Manganese oxide	0.65		
Cobalt oxide	0.23	ORb 4.0, ORa 7.0, $SiO_2.B_2O_3$ 3.6	

Milled with 6% clay and 2½% dissolved borax. Similar ground coat used except that 0.03 equivalent CaO replaces the CoO.

Cobalt ground coat	Per cent		Graphic formula
Feldspar	36.42	0.642 Na_2O	
Borax	35.54	0.080 K_2O	
Quartz	14.38	0.213 CaO	0.203 Al_2O_3 { 2.260 SiO_2
Soda	7.42	0.040 CoO	0.628 B_2O_3
Fluorspar	4.64	0.025 MnO	0.201 F_2
Manganese oxide	0.65		
Cobalt oxide	0.95	ORb 4.0, ORa 7.0, $SiO_2.B_2O_3$ 3.6	

Milled with 6% clay and 2½% dissolved borax.

Each of these enamels has been coated with two white cover coats and then tested under the hammer, and it is to be noticed that the noncobalt ground coat leaves the steel entirely bright and bare, while the one containing cobalt still adheres in concentric ridges. It is very evident that the cobalt must cause the extra adhesiveness. To illustrate the reduction of a metal oxide, the following enamel was used:

0.451 Na_2O		
0.019 K_2O		
0.123 CaO	0.111 Al_2O_3	{ 0.886 SiO_2
0.285 ZnO		0.282 B_2O_3
0.122 CuO		0.123 F_2

This enamel when used over a ground coat is green, but when applied directly to the steel, becomes red through the reduction of the copper compound. (Discussion by R. C. Purdy and H. F. Staley.) (*Chem. Abs.*, **7**, 232 (1913).)

Landrum, R. D.

MANUFACTURE OF ENAMELED WARE. *Trans. Kansas Acad. Sci.*, **22**, 76.—A brief but interesting description, from a chemical standpoint, of the enameling of steel. (*Chem. Abs.*, **4**, 1532 (1910).)

***Landrum, R. D.**

QUESTION OF ANNEALING PORCELAIN PARTS INTERESTING. See this *Bibliography*, p. 106.

EFFECT OF VARIATION IN THE COMPOSITION OF GROUND COATS FOR SHEET-IRON ENAMELS. See Danielson, R. R. (this *Bibliography*, p. 83).

MODIFICATION OF MOLECULAR FORMULA FOR GLAZE AND ENAMEL CALCULATIONS. See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 38).

TRANSPARENT ENAMELS. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 41).

EFFECT OF MUFFLE ATMOSPHERE ON FIRING ENAMELS. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 43).

ZIRCONIA IN ENAMELS. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 41).

PLASTIC PROPERTIES OF ENAMEL SLIP. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 44).

VARIATION IN COMPOSITION OF GROUND COAT FOR SHEET-IRON ENAMELS. (Discussion.) See Danielson, R. R. (this *Bibliography*, p. 84).

REFERENCE BOOKS ON ENAMELS. See *Jour. Amer. Ceram. Soc.* (this *Bibliography*, p. 166).

Landrum, R. D., and Frost, L. J.

TITANIUM ENAMELS. *Jour. Amer. Ceram. Soc.*, **3**, 316 (1920).—(1) A too high content of TiO_2 increases the specific gravity of a frit to such an extent that it is extremely

NUMBER	GRAPHIC FORMULA	SMELTING TIME	MILLING	FRIT	OPACITY	ACID LOSS	HEATING TESTS	IMPACT	GLOSS	REMARKS
1	.488 Na_2O .056 K_2O .446 CaO .445 { 1.263 SiO_2 / TiO_2 }	20 MIN 34.	65 In_2O_2 7% Clay 1.4% NiO 26% 23.	Yellow Tint Clear Heavy 40% 20	Very Poor 17% 6.	None (No effect) 05%	Very Excl. 16	Good 12%	Excl.	This glaze is exceptionally durable
2	.507 Na_2O .030 K_2O .463 CaO .463 { 1.233 SiO_2 / TiO_2 }	20 MIN 34	10% Clay ½% NiO 08% 24	Yellow Green Clear Heavy 35% 21	Very Poor 34% 2	None (no effect) 77%	Very Good 17	Good 06%	Excl.	Similar to # 1
3	.488 Na_2O .066 K_2O .446 CaO .446 { 1.338 SiO_2 / TiO_2 }	21 Min 35	10% Clay ½% NiO 57% 22	Pale Green Clear Heavy 92% 19	Very Poor 77% 5	None (No effect) 93%	Very Good 15	Very Good 81%	Good	Similar to 1 & 2
4	.726 Na_2O .055 K_2O .219 CaO .166 { 1.663 SiO_2 / TiO_2 / .588 B_2O_3 }	15 MIN 16	20% Clay 1% NiO 88% 32	Pale Green Soft 63% 9	Not Comparable 29% 4	67% 30	90% 5	63%	Good	Of no value as an enamel
5	.612 Na_2O .092 K_2O .296 CaO .558 { 2.80 SiO_2 / TiO_2 / .664 B_2O_3 }	12 MIN 6	20% Clay 1% NiO 54% 25	Green Soft 26% 11	Poor Unmelted (Highest) 53% 7	Not Tested 23% 32	Fair 05% 17	Good 39%	Good	Exceptional fire resistance and long burning range.
			QUARTZ	SODA	CALCITE	SALTPETER	BORICACID	RUTILE		

difficult to keep it in a satisfactory state of suspension by ordinary means. (2) The extent of the yellow discoloration is not directly proportional to the amount of rutile and nitrate in the enamel, but seems to depend also upon other chemical balances not yet determined. Thus, an enamel with a large amount of rutile and the proper per cent of nitrate may have less discoloration than one with correspondingly less of each material. (3) The opacity is also somewhat independent of the amount of rutile present. As

PANEL	GRAPHIC FORMULA	SMELTING TIME	FRIT	MILLING	OPACITY	ACID LOSS	HEATING TESTS	IMPACT	GLOSS	REMARKS
6	.489 Na_2O .066 K_2O .445 CaO | .445 TiO_2 | .1263 SiO_2 .066 Sb_2O_5	25 MIN 31	Ivory Very Opaque Heavy 66%	10% Clay ½% MgO	Quite Good 5	None 5.93%	Very Good 18 69%	Very Good 14	Excl. 88%	Difficult to apply 18 69% 10 57%
7	.487 Na_2O .066 K_2O .447 CaO | .145 Al_2O_3 | .1267 SiO_2 .447 TiO_2 .320 F_2	25 MIN 33	Ivory Very Opaque 50%	6% SnO_2 7% Clay ½% MgO 27	Very Good 5	.0017 Gr. 9%	Poor 2 33%	Good 15 37%	Good 15 77%	The failure in heating test caused by corrosion of ground coat.
8	.742 Na_2O .078 K_2O .180 CaO | .300 Al_2O_3 | 2.444 SiO_2 .371 TiO_2 .768 F_2 39	18 MIN 72 20	Yellow Brown Med. Uneven Opacity 11%	6% SnO_2 7% Clay ½% MgO 13	Good 8 1%	None 12	Very Good 28% + 31%	Very Good 9	Very Good 77%	This enamel worked well.
9	.672 Na_2O .142 K_2O .186 GaO | .310 Al_2O_3 | 2.521 SiO_2 .398 TiO_2 .794 F_2 39	16 MIN 14% 19	Creamy White Med. Opacity 34%	6% SnO_2 7% Clay ½% MgO 13	Good 70% 3	.0006 gr. 9.4%	Good 8 39% +	Poor 26% 10	Very Good 04%	Failure of impact test due to defective ground. Enamel worked well.
10	.536 Na_2O .146 K_2O .318 CaO | .332 Al_2O_3 | 2.710 SiO_2 .152 B_2O_3 .270 TiO_2 1.067 F_2 36	40 MIN 60% 22	Creamy White Good Opacity 19% 7	6% SnO_2 7% Clay ½% MgO 15% 15	Quite Good 74% 3	.0024 gr. 9.2%	Excl. 7	Very Good 08% 6	Very Good 30%	A very durable enamel.

| | | |

claimed by Vondracek, TiO_2 precipitates out of the molten solution in the form of invisible crystals, but the extent of this crystallization is more dependent on the composition of the enamel than on the exact amount of TiO_2 present. Just what the most suitable compositions are have not yet been determined, but apparently the presence of B_2O_3 is desirable, although this constituent may be replaced entirely by TiO_2 as far as most of the resulting enamel properties are concerned. (4) The theory of the opacity from TiO_2 by means of its precipitation within the enamel is backed by the fact that some rutile enamels are easy to overfire, especially when they are opaque and in the absence of tin oxide. When a certain excess of crystals has formed within the enamel, they appear to break through the surface with a consequent loss of gloss. This one point might limit to some extent the procurement of the maximum opacity from TiO_2 in the melt. (5) The most promising feature of the possible use of rutile is shown by the fact that practically all enamels containing it show unusual durability under all tests. The chemical resistance is always greatly superior to the ordinary kitchenware enamels, and the very high gloss which many of the enamels develop makes a surface which is especially resistant to abrasion and the consequent failure of the enamel after the surface is once broken. The heat resistance is also greatly improved and the resistance to impact is fully as good as is found with other average enamels. (6) Preliminary experiments indicate that TiO_2 has no place in a ground coat. When 0.1 molecule of TiO_2 was added to a normal ground coat, the cobalt blue was somewhat destroyed, the melting point was so lowered as to cause firing off, and the enamel did not combine properly with the steel. The elasticity remained as good, however, and possibly was somewhat improved. (7) The direct addition of 1% of cobalt oxide to enamel I of Series A did not result in any of the usual ground-coat properties. The enamel was softer, more brittle, did not fire down properly and had very little adherence. By way of final conclusions, it might be said that the good qualities resulting from the use of titanium seem to more than offset the bad ones and it seems possible to overcome some of the difficulties and develop enamels of very substantial practical value. (*Chem. Abs.*, **14,** 2688 (1920); *Chem. and Ind.*, **39A,** 546 (1920).)

Lang, Albert

OXIDIZING AND COLORING OR ENAMELING ALUMINUM OBJECTS. German Pat. 182,415, Feb. 7, 1906; addition to 163,545, Aug. 7, 1904.—This differs from the principal patent in that the surface of the aluminum is oxidized by such metallic compounds as form thereby colored precipitates or are reduced to the metallic state, as metallic chlorides, after whose fixing, as by ignition, colors, lakes, or galvanic precipitates can be formed on the surface. (*Chem. Abs.*, **1,** 2441 (1907).)

***Lassieur, A.**

DETERMINATION OF SULPHUR IN IRON. See Kling, A. (this *Bibliography*, p. 174).

Later, E. P.

PROTECTIVE COATINGS: JAPANS AND ENAMELS. *Foundry*, **45,** 139 (1917).—A brief review of the manufacture and uses of air drying and baking japans and varnish enamels, and of fused silicate enamels, used for coating metals. (*Chem. Abs.*, **11,** 1755 (1917).)

Lawlor, Edward W.

PRACTICAL DISSERTATION ON PEBBLE MILLS. *Ceram. Ind.*, **2,** 369 (1924).—In order to eliminate iron contamination from man-hole covers on ball mills, it is suggested to line the cover with a block of rubber instead of silex. This would also insure a tight fit. It costs, in material and labor, about $300 to line a 6- by 8-ft. mill with silex. The

inside diameter of the mill is reduced six inches. The mill is out of operation for one week. The surplus lime-carrying cement must be removed by running awhile after relining. A $^5/_8$-inch rubber lining (*India Rubber World*, Aug. 1, 1923 and Nov. 1, 1923) was run in an ore mill loaded with iron balls for nine months and was still in good condition, whereas a silex lining would have worn out in six to eight months. After three months' service running 24 hours per day and after having ground at least 1000 tons of ore, no signs of wear were apparent. It would take two men five hours to replace an entire rubber lining. The rubber is made in man-hole size strips. Rubber lining increases the capacity of the mill and reduces the cost of grinding. Any small particles of rubber passing through the sieve would be readily fired out of the ware. Irregular-shaped pebbles grind better than round ones as the voids are reduced. The mill should be half full of pebbles and the charge about 23% of the total cubic capacity or 1 cubic foot of pebbles to $^1/_2$ cubic foot of material. (*Ceram. Abs.*, **3**, 271 (1924).)

Lawler, Edw. W.

PEBBLE MILLS AND THEIR USE. *Enamelist*, **2** [2], 7 (1924).—Mills must be set true, so gears will properly mesh, etc. Good hard white porcelain will give twice the wear as a soft yellow porcelain. The linings must fit properly. Rubber linings (Linerite) will soon be on the market. These will aid in reducing operating costs. The right kind and size of pebbles is important. Uniform size is better than mixed sizes. Total inside cubic contents divided by two equals the volume of pebbles to be used; $23^1/_2$% of the cubic content is the amount of dry material that may go in as a charge.

Lawler, E. W.

DESIGN AND OPERATION OF BALL AND PEBBLE MILLS. *Chem. Met. Eng.*, **30**, 517 (1924).—The main factors involved in noncontinuous ball or pebble mills are: (1) for mill design: shape, proportions, lining, and discharge openings; (2) operating factors: size of feed, feed load, kind, shape, size and load of balls or grinding media, wet or dry grinding, speed of mill, and time of grind. A pebble mill is a pulverizer rather than a crusher. Pulverizing can best be done by attrition instead of by impact. The time of grinding is determined best by counting revolutions rather than by actual time. (*Ceram. Abs.*, **4**, 83 (1925).)

Lawler, Edw. W.

APPLICATION OF PEBBLE OR BALL MILLS IN ENAMELING. *Jour. Amer. Ceram. Soc.*, **8**, 853 (1925).—A description of pebble mills in enameling is given; details of design and results are discussed. For one cubic foot of dry frit, the mill should be 4 cu. ft. inside the lining and 2 cu. ft. of pebbles should be used. The water added should be in about the proportion of 35 to 40% of the frit volume. The diameter of the mill should not be less than the length. A mill with sloping sides will make discharging easier. The manhole frame of a mill should be flush with the shell of the mill and not with the lining. As a lining for enameler's mills, rubber will surpass and displace all other materials for wet grinding. Dry grinding develops heat which might deteriorate the rubber. Other linings are porcelain brick, silex, etc. Porcelain or flint pebbles may be used. Pebbles of the smallest size that will do the work should be used. Viscosity in wet grinding should be such that the pebble moves freely but not too freely. Best results are obtained by rotating the mill at such a speed that the pebbles will drop vertically and not roll. (*Enamelist*, **2** [5], 9 (1925); *Chem. Abs.*, **20**, 808 (1926).)

Lawrence, G. R.

HEAT-INSULATING WALLS FOR PORTABLE ENAMELING OVENS. U. S. Pat. 1,486,528, Mar. 11, 1924.—A section or unit for a wall of an oven comprising a casing, non heat-

conducting material between the sides of the casing and perforated tie plates transversely uniting sides at edges thereof. (*Chem. Abs.*, **18**, 1737 (1924).)

***Lea, F. C.**

EFFECT OF ENAMEL ON TRANSMISSION OF HEAT. See Gibson, A. H. (this *Bibliography*, p. 131).

Leataud, Jean

MASTERS OF LIMOGES ENAMEL. *Int. Studio*, **88**, 44 (1927).—The fundamental condition of the creation of Limoges enamels was that each one was the production not so much of an individual artist as of a family. A few families include nearly the whole of painted enamel of the 16th Century. In Limoges alone the *émailleurs* formed distinct guilds and were not restricted as in Paris. With the advent of Nardon Pénicaud the character of the work changed from the primitive, bent on completely filling the field of decoration, to composition which was simplified and dramatic with restrained but unified color scheme. The first signed and dated Pénicaud piece was the Christ on the Cross described as a symphony in blue varied with gold, the draperies blue-violets and blue-greens. In vivid contrast are the flat white of the visage and the body of Christ. The glory of Limoges enamel was its coloring and technical perfection, not its unchanging theme. The second Pénicaud, Jean I, who worked in fresh greens, golden yellows, and full-toned reds was in a sense a realist where his brother was a lyric poet of color. The Resurrection of Lazarus was from his hand. Jean II represents the advent of pure Classicism and was a master of *grisaille*. Modeling in this process was obtained by layers of white enamel on a black background while delicate work with a needle played an important part. Portraits in this style are now in the Louvre. The painted enamels were less expensive and therefore more popular than the earlier cloisonné and champlevé. The Limosin family represent the culmination of the creative period. Pierre Raymond specialized in plates, ewers, cups, etc. The Noyliers workshop specialized in caskets, coffers, and jewel boxes. (*Ceram. Abs.*, **6**, 568 (1927).)

LeChatelier, and Chapuy, P.

COLORATIONS OF PORCELAIN ENAMELS. *Comptes Rend.*, **127**, 433 (1898).—The authors have studied the range of coloration produced by different metals on glazes in the porcelain kiln. The temperature of the kiln was kept at 1360 to 1390°C, the percentage of metal (added as oxide or other compound), and the composition of the atmosphere and of the glaze, being varied. The following are the principal colors obtained in the works furnace, independently of the more extended laboratory trials. Cr: *violet* (O), *blues* (O), green, yellow, *orange* (O), red (O); Co: blue, *green* (R), *rose* (R); Cu: blue, green, yellow, red; Di: *violet* (R), *blue* (R), *green* (R); Er: *violet* (R), *blue* (R), *green* (O), *red* (O); Fe: blue (R), green (R), yellow, red (R); La: *violet* (R), *blue* (R); Mn: *violet* (O), *blues* (O), greens, yellow, *reds;* Mo: *violet* (O), *blues* (O); Nd (neodymium): *violet* (R), *blue* (R), *green* (R); Ni: *violet* (O), blue (O), green, yellow, *red* (O); Ti: violets (R), blue (R), greens (R), yellow, red (R); W: *violet* (R), blues (R), yellow, *reds* (R); Tl: *blue* (R), *green* (R); Th: blue (R), green (R); and V: *blue* (O), *green* (O), yellow (O). In this list, italics indicate new or hitherto little known colorations. (O) and (R) indicate oxidizing and reducing atmospheres, respectively, but only the types of atmosphere which may vary in composition, *e.g.*, Cl, S, metallic vapors, etc. The same colors are often obtainable in different atmospheres, if one varies suitably the composition of the glaze and metallic compound employed. The chromium *blues* are obtained in an atmosphere of air, using a feldspar glaze in presence of zinc, on adding 0.5 to 1.2% of Cr_2O_3; with 1.2 to 1.5% *rose* develops; and at 1.6% the blue disappears. Di_2O_3 gives tints different from those given by pure Nd_2O_3, the latter being

not so bright; both give their colorations in the oxidizing atmosphere also, but the tints are duller. The violets, greens, and reds with TiO_2 were obtained without the addition of other color oxides, simply by varying the atmosphere. The blues of W were obtained by adding WO_3 to a glaze free from Ba. Analyses of some of the glazes are given at the top of the adjoining column. Among the colorations the authors obtained in the porcelain kiln are the following, as presenting most interest: *violet tints* from Cr, Mn, and Di; *blue tints* from Y, V, Mo, W; tints similar to that from Ti, Cr, Fe, Mn, Th, Di, which approach the copper blues; *green tints* from Co, excellent; many greens from Fe, Mn, Ni, different from those already known; *red tints* from Fe; tungsten red is quite comparable with copper red; erbium red.

	Erbium			Neodymium		
	Blue	Green	Red	Violet	Blue	Green
SiO_2	42.5	31.5	60.8	59.9	63.5	47.3
Al_2O_3	8.8	6.2	11.6	10.8	11.8	9.3
CaO	1.5	4.9	1.1	2.0	1.4	1.3
SrO				11.8	17.3	
BaO	26.0		18.5			27.9
K_2O	0.5	0.4	0.7	0.7	0.6	0.5
Na_2O	1.7	0.9	1.9	1.8	1.3	1.8
B_2O_3	5.4					6.0
ZnO		46.8				
NdO				1.3	4.2	5.8
ErO	13.7	9.4	5.3			
	100.1	100.1	99.9	*100.0 (Sic.)	100.1	99.9

* The actual total should be 88.3. (*Chem. and Ind.*, **17**, 1048 (1898).)

***Lehmann, W. M.**

BEHAVIOR OF FLUORIDES IN GLASSES AND ENAMELS. See Agde, G. (this *Bibliography*, p. 3).

Leibl.

LEAD-FREE GLAZES. *Ctrlbl.*, p. 476 (1857); *Bull. d'enc.*, p. 56 (1858); *Dinglers' poly. J.*, **143**, 317. (*Rep. der Tech. Lit.*, p. 306 (1854–1868).)

Leissler, D.

ENAMELING OVEN. U. S. Pat. 1,447,795, March 6, 1923.—The oven is adapted for baking glazed articles. (*Ceram. Abs.*, **2**, 149 (1923); *Chem. Abs.*, **17**, 1700 (1923).)

Lenchs, G., and K.

PRODUCING CLOUDED GLASSES AND ENAMELS BY FIRED TITANIC ACID. British Pat. 18,152, Oct. 12, 1900.—In the production of clouded glasses and enamels, titanic acid, as powdered rutile, is usually melted with the other ingredients, with the result that perfect products are difficult to obtain; the inventors mix fired titanic acid with powdered or enamel glass, coat the articles, and fix the mixture produced by firing. (*Chem. and Ind.*, **20**, 990 (1901).)

***Leonard Refrigerator Co.**

NEW LEONARD PLANT, A MODEL FOR FLEXIBLE PRODUCTION. See Sealey, P. T. (this *Bibliography*, p. 275).

Leppla, G.

THE PLASTICITY OF CLAYS. *Baumaterialenkunde*, **9**, 124.

Leroux

IMPROVEMENT IN CONSTRUCTION OF ENAMELING OVENS. German Pat. 162 (1877). (*Rep. der Tech. Lit.*, p. 76 (1877).)

Lesme

GLAZES. *Monit. ind.*, No. 2232 (1858). (*Rep. der Tech. Lit.*, p. 306 (1854–1868).)

Lesmuller, A.

PROCESS FOR MAKING GLASS AND ENAMELS OPAQUE. German Pat. 218,316, April 1, 1909.—Oxides of tin, silicon, lead, titanium, zirconium, or thallium are fused with boric acid derivatives and the fused mass exposed to the action of steam or acid vapors while it cools and the solid product subsequently melted with the enamel. (*Chem. and Ind.*, **29**, 426 (1910).)

Levin, E.

PRE-ENAMELING. *Enamelist*, **4** [9], 16 (1927).—The cleaning of steel is one of those simplicities which cannot be overemphasized in good enameling practice. The "breaking of water" will indicate if steel is properly cleaned; *i.e.*, if the water will wet the steel, dry evenly, and not show signs of dividing or breaking, the steel is free from oil.

Liebing, B.

EMPLOYMENT OF CAST-IRON AND ACID-RESISTING ENAMELS IN CONSTRUCTION OF APPARATUS. *Apparatebau*, **38**, 49, 61, 73, 85 (1926).—High silicon cast iron, nickel chromium, and manganese alloys, acid- and heat-resisting enamels and enameled apparatus, with methods of making tight joints, are discussed. (*Ceram. Abs.*, **5**, 269 (1926).)

Lindemann, W. C.

ELECTRIC CLEANING OF METALS FOR ENAMELING PURPOSES. *Jour. Amer. Ceram. Soc.*, **3**, 252 (1920).—The results obtained with the electric process of cleaning have clearly demonstrated the advantages over the older scaling or firing-off method. Stated briefly these advantages are: (1) lower cleaning costs, (2) saving in time with corresponding greater output, and (3) elimination of sponging or scrubbing ware, to remove the deposit of carbon formed during scaling. The success of the electric method of cleaning has suggested the application of electricity to pickling. Experiments have shown that the ware so handled is put into better condition for enameling, but the process curtails extra cost beyond the gain in condition of the metal. (Discussion by F. G. Jaeger.) (*Chem. Abs.*, **14**, 2063 (1920).)

***Lindemann, W. C.**

TESTING CROSS-BENDING STRENGTH OF ENAMELS. See Danielson, R. R. (this *Bibliography*, p. 86).

WET-PROCESS ENAMELS FOR CAST IRON. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 39).

PLASTICITY. See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 42).

Lindsay, George W.

CRANE HINGE FOR MUFFLE-FURNACE DOORS. U. S. Pat. 1,346,903, July 20, 1920.—A mounting for muffle-furnace doors comprising in combination with the furnace and its door, a crane hingedly mounted at one end on the furnace and having a swivel connection at its other end with the door of the crane portion of the swivel connection being positioned above the door, whereby the door may be swung out beneath the crane. (*Jour. Amer. Ceram. Soc.* (Abs.), **3**, 772 (1920).)

Lindsay, William

ENAMELING POWDER DISTRIBUTER. U. S. Pat. 1,273,632, July 23, 1918.—A reservoir adapted to hold a quantity of enameling powder and having a discharge outlet; means for discharging powder from the reservoir through outlet, the means including a suspended reciprocating member adapted to have a constant oscillating motion about its own longitudinal axis to positively feed the powder toward the outlet.

Lindsey, Gordon S.

FACTORS INFLUENCING PICKLING OF SHEET IRON FOR ENAMELING. *Enamelist*, **5** [1], 21 (1927).—Sulphuric acid 5 to 8% is usually used at a temperature of 140 to 160° F. Hydrochloric acid of 10 to 12% is generally used cold, because of fumes when heated. An increase of 20% in temperature will compensate for a decrease of 2% in acid concentration in the rate of pickling. This condition cannot be duplicated in practice, but the rate does increase by from 50 to 75%. The presence of iron in the solution will slow down the action of a sulphuric acid solution. This is not very noticeable until the concentration of the iron reaches 8%. Sheet iron will pickle faster in Monel baskets than in wooden ones. This is due to an electrolytic action between the sheets and the Monel basket.

Lindsey, Gordon S.

OBSERVATIONS ON "HAIRLINES" IN SHEET-IRON ENAMELS. See Hansen, J. E. (this *Bibliography*, p. 145).

FACTORS INFLUENCING THE RATE OF PICKLING OF SHEET IRON. See Hansen, J. E. (this *Bibliography*, p. 146).

Linke, Wilh.

PLAN AND MANAGEMENT OF MODERN ENAMELING FACTORY. *Glashütte*, **44**, Nos. 14–52 (1914); *ibid.*, **45**, Nos. 1–36 (1915). (*Chem. Abs.*, **8**, 3715 (1914); *ibid.*, **10**, 513 (1916).)

Lissner, A., and Horny, R.

IDENTITY OF TEMPER CARBON AND IRON GRAPHITE. *Stahl u. Eisen*, **45**, 1297 (1925).—The conclusion is drawn from the chemical behavior of graphite from gray iron and temper carbon precipitated during annealing of white iron, that the two forms of carbon are identical. Owing to its more finely divided condition, the temper carbon ignites at a lower temperature, but both have the same heat of combustion, both yield the same graphitic acid, and both resist the action of HNO_3, H_2SO_4, and fused $NaHSO_4$. (*Ceram. Abs.*, **5**, 11 (1926); *Chem. and Ind.*, **44B**, 72 (1925).)

***Liston, Daniel A.**

CONTINUOUS-FIRING FURNACE FOR FIRING ENAMELWARE. See Bickmeier, C. (this *Bibliography*, p. 20).

Littlefield, M. S.

PRELIMINARY REPORT OF INVESTIGATION OF MOLDING SAND RESOURCES OF ILLINOIS. Ill. State Geol. Surv. Rept. of Invest., Vol. 3 (1925).—A 37-page report. (*Ceram. Abs.*, **4**, 331 (1925))

Livache, A.

REPORT ON DORMOY'S APPARATUS FOR MECHANICAL ENAMELING WITHOUT DISSEMINATION OF DUST. *Bull. Soc. d'Encouragement*, **101**, 17 (1901).—The apparatus is essentially as described in the original patent (above *Journal*, p. 761 (1899)), save in two points. (1) The strong indraft is used to raise the surplus enamel powder from the

collecting box at the bottom of the apparatus to the hopper at the top. (2) The object is retained on the table not by electro-magnetic apparatus, but by furnishing the table with a number of little balanced levers working on horizontal axes, and so arranged that a counterpoise at one end of each makes the other end project 10 to 15 mm. above the surface of the grids. The object presses down the projecting ends of the levers on which its weight rests, and is kept from slipping by the surrounding projections. The advantages of the apparatus are (1) complete protection of the workers from the enamel dust; (2) lessening of discomfort from radiant heat, the glass door being between the workman and the hot object; (3) greater rapidity of work; a given piece of work was done in the apparatus in half the time that was taken to do it by hand; a number of small articles can be laid on the table at once, instead of each being handled separately; (4) economy of enamel, since the excess is used again; (5) less manipulative skill is needed than in the hand process. The work people prefer the new process to the old. Several copies of the apparatus have been constructed by M. Dormoy for use in foreign works, and all have given complete satisfaction, not only as affording protection to the workers, but also as producing work of a very high quality. (*Chem. and Ind.*, **20**, 251 (1901).)

Loeser

USE OF SODIUM SILICO-FLUORIDE IN THE GLASS INDUSTRY. *Glashütte*, **44**, 145, 165 (1914).—L. believes that sodium silico-fluoride will displace cryolite and fluorspar as clouding agents in opal glasses. A batch of sand 100, potash 16, soda 10, cryolite 14, lead 10, saltpeter 4, and borax 2, is recalculated using sodium silico-fluorides in place of cryolite as follows: sand 92.2, potash 16, soda 13.5, sodium silico-fluoride 12.5, kaolin 8.5, lead 10, saltpeter 4, and borax 2. See Eyer, P. (this *Bibliography*, p. 116). (*Chem. Abs.*, **8**, 1652 (1914).)

Lorah, James R.

URANIUM OXIDE COLORS AND CRYSTALS IN LOW TEMPERATURE GLAZE COMBINATIONS. *Jour. Amer. Ceram. Soc.*, **10**, 813 (1927).—A study has been made of the color and crystallization of some uranium, lead, sodium, and boron glazes fired in a pure oxidizing atmosphere, both alone and with the addition of certain inorganic compounds. The colors obtainable are yellow, orange, green, brown, and black. By using only uranium oxide and red lead it is possible to produce any shade from light yellow to dark orange or red. About 10% of yellow uranium oxide is required to produce the deepest shade of orange. A study has been made of the crystals found in these glazes and the effect on them of adding clay and certain other compounds, and of increasing the time of firing. It is shown that the volatilization of lead is a very great factor in the preparation of crystalline structures. (*Ceram. Abs.*, **6**, 539 (1927).)

Lotterhos, G.

ENAMEL. Danish Pat. 22,409, Sept. 3, 1917.—Borax is replaced by glass containing easily fusible fluxes. (*Chem. Abs.*, **12**, 413 (1918).)

Lotterhos, G.

ENAMELS. Swiss Pat. 72,174, April 17, 1916.—Low melting glazes containing flux are used as a substitute for the fluxes containing boron. (*Chem. Abs.*, **10**, 2511 (1916).)

***Louisville Enameled Products Co.**

INDUSTRY'S NEWEST AND FINEST PLANT. See McBride, P. B. (this *Bibliography*, p. 211).

***Lowe, G. M.**

FLOW OF STARCH PASTE THROUGH CAPILLARY TUBES. See Farrow, F. D. (this *Bibliography*, p. 118).

Lunan, Thomas M.

MANUFACTURE OF ENAMELED WARE. U. S. Pat. 758,325, April 26, 1904.—The cleaned article is coated with an enamel carrying metallic bodies, a nonmetallic hydroxide added and heated to flux and set the enamel. (*Chem. and Ind.*, **23**, 546 (1904).)

Lustig

IMPROVEMENTS IN METAL AND ENAMEL WORK. Specif. No. 2997, 1874. *Rep. der Tech. Lit.*, p. 38 (1874).

Lutwyche, W.

TRANSLUCENT ENAMEL. British Pat. 10,322, June 25, 1889.—The following materials are used in the production of this translucent enamel: minium, boracic acid, oxide of zinc, stannic acid, sand, soda, feldspar, fluorspar, potassium carbonate, calcium carbonate, borax, and sodium nitrate. The coloring matters are manganese dioxide, purple of Cassius, ferric oxide, lead chromate, cobalt oxide, cuprous oxide and cupric oxide. (*Chem. and Ind.*, **8**, 781 (1889).)

Lutwyche, W., and W. B.

TRANSLUCENT ENAMEL. U. S. Pat. 634,117, Oct. 3, 1899.—The herein-described composition of matter to be used in the manufacture of translucent enamel, consisting of minium, boracic acid, zinc oxide, stannic acid, powdered flint, feldspar, fluorspar, pearl ash, sel de St. Gobain, bone ash, calcined borax, niter, chloride of sodium, the compound hydrate of alumina, and hydrated protoxide of cobalt, oxyde noir de Dubois, oxide of antimony, oxide of uranium, and carmine.

Lutwyche, W., and W. B.

TRANSLUCENT ENAMEL. British Pat. 5934, Mar. 21, 1895.—The inventors claim the use of the following materials in the proportions named for the production of translucent enamel:

	Parts		Parts
Boric acid	80–100	Pearl ash	2–5
Zinc oxide	50–80	Carbonate of soda	20–30
Stannic acid	30–40	Bone ash	5–9
Powdered flint	50–60	Calcined borax	8–12
Feldspar	5–10	Niter	2–5
		Sodium chloride	5–9

For coloring the enamel blue, hydrate of alumina and hydrated protoxide of cobalt may be used; for black, the preparation of oxide of manganese known as "oxyde noir de Dubois;" for yellow, oxide of antimony or oxide of uranium; for pink, carmine. (*Chem. and Ind.*, **15**, 198 (1896).)

Lynde, Charles C.

PRODUCTION OF STAMPED AND ENAMELWARE. *Steel and Iron*, **50**, 211.

MacDougall, Robert

CONTINUOUS FURNACE ENAMELING RECORD. *Ceram. Ind.*, **8**, 209 (1927).—A description of the Beemack continuous drying and firing furnace, producing 500,000 pieces per month. (*Ceram. Abs.*, **6**, 133 (1927).)

MacDougall, Robert

RECUPERATOR OIL SMELTER. *Jour. Amer. Ceram. Soc.*, **8**, 541 (1925).—A recuperator was built at small cost to serve a unit of two oil-fired smelters. These smelters

have shown a fuel saving of $2500 per year over cost of coal for smelters formerly used, besides saving the labor of one man. An improved product results from better furnace control possible with oil fuel and preheated air for combustion. (*Enamelist*, **2** [5], 24 (1925).)

MacDougall, R.

FURNACE FOR ENAMELING METALWARE. See Beasley, H. C. (this *Bibliography* p. 16).

Mackey, F. C., and Gumz, J. H.

ENAMELING FURNACE. U. S. Pat. 1,453,051, April 24, 1923.—An enameling furnace is provided with a refractory lining with a checkered surface. (*Chem. Abs.*, **17**, 2178 (1923); *Chem. and Ind.*, **42A**, 552 (1923).)

MacMichael, R. F.

PHENOMENA OF CLAY PLASTICITY EXPLAINED. *Brick Clay Rec.*, **55**, 677 (1919).—The strength of clay, whether plastic, dry, or fired, is due to molecular cohesion of the clay particles themselves. The property of cohesion is illustrated by Swedish gages. These gages are pieces of hardened steel, the ends of which are accurate and true. When the ends of two of these gages are carefully cleaned and placed together in such a manner as to exclude the air, they will be found to cohere with considerable force (as high as 35 lbs. per sq. in. when tested in a vacuum). If the surfaces are wetted with oil, the gages fall apart just as water causes clay grains to separate. Plasticity results from the balancing forces of cohesion and disruption. Fluids other than water may be used to produce plasticity in clay. Organic matter, soluble salts, and colloids, except as the latter are considered to be merely fine, insoluble particles of the clay itself, are not essential to plasticity. (*Jour. Amer. Ceram. Soc.* (Abs.), **2**, 906 (1919).)

***Maddock**

See Binns, C. F. (this *Bibliography*, p. 25).

Mades, R.

PRODUCTION OF A NONCHIPPING ENAMEL. German Pat. 396,752, Dec. 29, 1922.—The ground coat is applied in so dilute a condition that after firing it is invisible to the naked eye. Thus, the finished ware can be subjected to very considerable shocks and blows. (*Ceram. Abs.*, **3**, 336 (1924); *Chem. and Ind.*, **43B**, 788 (1924).)

Maehler, A.

ENAMELING OVENS. U. S. Pat. 1,523,655, Jan. 20, 1925.—The articles are carried by a horizontally arranged endless carrier through alternately arranged dipping stations and drying chambers. The combination of a series of drying chambers, an endless carrier associated with the chambers, and a longitudinal chamber arranged at the roof of the chambers and adapted to house the return run of the endless carrier. (*Chem. Abs.*, **19**, 879 (1925).)

Malinovszky, A.

FREE QUARTZ IN FELDSPAR. *Ceramist*, **6**, 512 (1925).—The importance of knowing the free quartz content is discussed. Values are given for four samples with calculated values for free quartz. The basis of the calculation is the following proportion:

$$\frac{A \times b}{c} = X$$

where $A = SiO_2$ (pure feldspar) $\quad c = Al_2O_3$ (pure feldspar)
$b = Al_2O_3$ (impure feldspar) $\quad d = SiO_2$ (impure feldspar)

$(d - X)$ is then taken as the free quartz. NOTE: In a later article H. F. Staley (*Ceramist*, (this *Bibliography*, p. 62)), points out that Watkins (*Enamelist* (this *Bibliography*, p. 328)) used the above calculation for a specific analysis and that this formula should not be used as a method of calculating the free quartz in feldspar. (*Enamelist*, **3** [2], 11 (1925).)

Malinovszky, A.

TABLES FOR CALCULATING MELTED WEIGHT AND COEFFICIENT OF EXPANSION OF ENAMELS. *Ceramist*, **7**, 23 (1925).—M. gives tables and shows how they can be used for simplifying the calculation of melted weights and coefficients of expansion of enamels as well as the constituents in a feldspar and melted borax. The simplification results in a saving in time and a gain in accuracy. (*Ceram. Abs.*, **5**, 80 (1926).)

Malinovszky, A.

TABLES TO FACILITATE CERAMIC CALCULATIONS. *Ceramist*, **8**, 570 (1926).—The following tables are given for the following calculations: (1) mols of oxides from a formula or analysis; (2) weight of oxide from a molecular formula; (3) mols of oxide constituents with pure kaolinite, china clay; (4) mols of oxide constituents from pure orthoclase; (5) mols of oxide constituents from borax; (6) mols of oxide from various chemicals; (7) conversion of CaF_2 and AlF_3 to CaO and Al_2O_3; (8) mols of oxide constituents from pure borocalcite; (9) mols of oxide constituents from theoretically pure talc. (*Ceram. Abs.*, **6**, 116 (1927).)

Malinovszky, A.

COOLING ENAMEL BY COMPRESSED AIR. *Jour. Amer. Ceram. Soc.*, **6**, 972 (1923).—Water cooling is economical in milling but otherwise it has its disadvantages. Brittleness and some of the desirable chemical and physical qualities of the molten mixture are changed. The light pieces and all the soluble ingredients of the opacifying agents are flushed away. The opacifying power of the costly metal oxides is reduced. In the case of powder enamel, the water cooling involves an extra expensive drying process before grinding. If, as the molten mass is discharged from the spout of the furnace, it is subjected to a stream of compressed air, the mass will be so shattered that it will grind easily and yet not have suffered loss of properties or of any of its constituents. The molten stream of enamel will be separated into small particles and blown a sufficient distance to become cooled. The molten enamel is separated into very fine flakes or into threads. This is controllable by the air pressure and is influenced by the viscosity of the enamel. Enamel cooled by compressed air is separated and not shattered and therefore will retain its original chemical and physical strength and will hold its elasticity. Numerous tests and experiments with different steel and castings have shown that fish-scaling is thus avoided. It also has proved to be more acid-proof, does not easily chip, crack, or blister and withstands blows and shocks better in shipping and use. It eliminates drying before grinding and the enamel will grind in one-seventh of the usual milling time. (*Chem. Abs.*, **17**, 3911 (1923).)

Malinovszky, A.

ENAMELING DEFECTS DUE TO CAST IRON. *Jour. Amer. Ceram. Soc.*, **8**, 72 (1925).—Troubles in manufacturing sanitary enameled ware are pinholing, breaking out, blistering, crazing, chipping, lifting, black specks, etc., due to the iron, the chemicals, methods of applying the slush or enamel, furnace temperatures, inexperience, lack of cleanliness, differences of the coefficients between iron and enamel, and fitting of ground coat to the enamel, etc. Feldspar is most liable to cause trouble by variations of its constituents. Feldspar containing more than 69% of silica should be looked upon with suspicion. Troubles arising from cast iron are discussed. Results of chemical and microscopic

examinations and microphotos before and after enameling are shown. Carbon has an intimate connection with the cause of blistering, lifting, and, in some cases, with chipping. This is demonstrated by the chemical analyses as well as by the microphotos. A low combined carbon and an evenly distributed graphitic carbon in very minute state will show no signs of blistering. As soon as the combined carbon is high and if temper carbon is present the blistering of enamel is certain. M. is unable to account for the increase of the carbon in the iron due to enameling heat treatment. The changes in the combined carbon (in the pearlite) during the enameling process, mean quite a radical difference in structural composition of the castings, the consequences of which the enamel must bear. It is necessary to secure as nearly as possible uniform pig and scrap iron, and good quality of a dense and strong structure coke. All finished castings must have a uniform thickness, otherwise chipping, lifting, crazing, also pinholes, are certain. (*Chem. and Ind.*, **44B,** 172 (1925); *Chem. Abs.*, **19,** 1039 (1925).)

Malinovszky, A.

DEFECTS IN ENAMEL DUE TO CAST IRON. *Jour. Amer. Ceram. Soc.*, **9,** 805 (1926).—Microphotographic examination of iron on which enamel has pinholed, blistered, and come perfect are cited as evidence that carbon is practically the only agent in cast iron causing blistering and pinholing and that it is the condition and not the presence of carbon that causes these defects. (*Chem. and Ind.*, **46B,** 749 (1927); *Chem. Abs.*, **21,** 635 (1927); *Ceram. Abs.*, **6,** 50 (1927); *Enamelist*, **4** [4], 14 (1927).)

Malinovszky, A.

MICROPHOTOGRAPHIC STUDY OF FREE QUARTZ IN FELDSPAR. *Jour. Amer. Ceram. Soc.*, **10,** 23 (1927).—The study presented in this article is of the quantity and variations of the free quartz in feldspar estimated by means of microphotographs and calculations based upon them. (*Ceram. Abs.*, **6,** 108 (1927); *Chem. Abs.*, **21,** 634 (1927); *Chem. and Ind.*, **46B,** 220 (1927).)

Malinovszky, A.

AGREEMENT OF GROUND COAT AND ENAMEL. *Jour. Amer. Ceram. Soc.*, **10,** 275 (1927).—Troubles in working with enamels may be caused by poor workmanship in some department as by changes in composition of the enamel due to differences in chemical composition of raw materials used. The application of Staley's refractory ratio in determining the agreement of ground coat and enamel cover coat is illustrated. (*Ceram. Abs.*, **6,** 212 (1927); *Chem. Abs.*, **21,** 1875 (1927); and *Chem. and Ind.*, **46B,** 442 (1927).)

Malinovszky, A.

REFRACTORY VALUE OF ENAMELS. See *Ceramist* (this *Bibliography*, p. 62).

***Malleable Iron Range Co.**

BLOWERS CUT FUEL COSTS. See Weimer, L. S. (this *Bibliography*, p. 330).

Manion, L. W.

MUFFLE FURNACE. U. S. Pat. 1,607,681, Nov. 23, 1926.—In a furnace of the character described, a muffle provided with a bottom wall of substantially uniform thickness throughout its area having alternate similar ridges and depressions, the ridges being arranged to support firing racks and the depressions being arranged to receive charging forks. (*Ceram. Abs.*, **6,** 10 (1927).)

Manly, Rowland

PROCESS OF ENAMELING WITH INDUSTRIAL GAS. *Am. Gas Assoc. Monthly*, **6,** 169 (1924).—The furnace design for satisfactory enameling must insure uniform tem-

perature and a constantly maintained pure atmosphere. Relative costs of coal and gas for enameling furnaces, including labor, overhead, etc., are discussed and favor the use of gas. (*Chem. Abs.*, **18**, 3692 (1924).)

***Mansfield (Ohio) Vitreous Enameling Co.**

NOVEL HEATING SYSTEM IN ENAMEL PLANT. See *Ceram. Ind.* (this *Bibliography*, p. 56).

Manson, M. E.

LOW PRODUCER GAS COST IN ENAMELING INDUSTRY. *Ceram. Ind.*, **8**, 439 (1927).—As long as coal is to be the source of heat, M. believes that more value per dollar is obtained by first gasifying the coal. Costs with producer gas appear lower than for direct-fired furnaces.

Manson, M. E.

EFFECT OF SOURCES OF PIG IRON UPON THE ENAMELING OF CAST IRON. *Jour. Amer. Ceram. Soc.*, **5**, 806 (1922).—Cast iron made from certain "northern" pig iron blistered badly, while that made under the same conditions from "southern" pig iron enameled satisfactorily. The use of "northern" iron results in castings with low content of combined carbon although the other constituents usually determined in cast iron were present in about the same quantities as found in cast iron made from "southern" pig iron. Reducing the silicon in the iron made with the "northern" pig iron from 2.8 to 2.3% with a total carbon content of 3.3%, resulted in elimination of blistering in enameling operations. Experiments have indicated that cast iron of this type with combined carbon less than 0.15% will develop blistering. It has not been definitely determined whether the blistering is due directly to this low carbon content or to the presence of some other constituent not generally determined in a chemical analysis of cast iron. Micrographs are shown of various irons before and after enameling. While these show some differences, it has been impossible to detect the cause for the blistering by means of them. All blistering irons, however, show in the micrographs characteristic dark blotches which have not as yet been identified. Castings from 800 lbs. southern, 300 lbs. northern, and 900 lbs. scrap, and those from 800 lbs. northern, 300 lbs. southern, and 300 scrap, had the same percentage of silicon, sulphur, phosphorus, and manganese, but the carbons were not identical. Discussion of this paper, *Bull. Amer. Ceram. Soc.*, **1**, 360 (1922) (this *Bibliography*, p. 40) by E. P. Poste and H. F. Staley. (*Chem. Abs.*, **17**, 193(1923); *Chem. and Ind.*, **41A**, 983 (1922).)

Manson, M. E.

BENTONITE FOR SUSPENDING ENAMELS. *Jour. Amer. Ceram. Soc.*, **6**, 790 (1923).—Bentonite, a highly colloidal clay, has a much greater suspending power than ordinary enameling clays. One part of bentonite is equivalent to five parts of clay. Its use enables the enameler to reduce the amount of raw materials necessary to add to his frit. Some disadvantages are pointed out. From the few experiments just outlined, it seems evident that by using bentonite as an enameling clay, the amount of raw addition to an enamel can be readily reduced. Theoretically, the finish of the resultant enamel should be improved, although further experimentation may disprove this. Even in the small amount necessary bentonite has a greater suspending power than other clays, which should be of advantage to those enamelers who coat with spray guns. But difficulties of manipulation are apt to turn up, which may more than offset the advantages of the material. This paper deals with this subject in a thorough manner; much research is still to be done. (*Chem. Abs.*, **17**, 3766 (1923); *Chem. and Ind.*, **42A**, 832 (1923).)

Manson, M. E.

COLOR OF ANTIMONY ENAMELS. *Jour. Amer. Ceram. Soc.*, **8**, 437 (1925).—Pure white antimony oxide does not give as good a color or opacity in enamels as the gray, impure, domestic product. The better color and opacity of enamels made with the latter is probably due to the impurities contained in the antimony. These experiments showed that only one kind of antimony oxide could be used in the formula. The cause of the difference in the color produced by the impure domestic oxide and the relatively pure Chinese oxide is undetermined. The solution may lie in colloidal chemistry. In 1923 in an article entitled "The Industrial Outlook for Colloid Chemistry" by H. N. Holmes, the following statement was made: "Since ions exist in melted salts there is a possibility that certain ions in a melted glass or enamel may peptize a pigment added to the melt." The composition of enamels might be changed so as to introduce desirable ions or even protective colloid material. Coagulation by ions may also merit study in such systems. (*Enamelist*, **2** [5], 7 (1925); *Chem. Abs.*, **19**, 3154 (1925); *Chem. and Ind.*, **44B**, 672 (1925).)

***Manson, M. E.**

ZIRCONIA IN ENAMELS. See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 41).

REFRACTORY VALUE OF ENAMELS. See *Ceramist* (this *Bibliography*, p. 62).

***Marchal, G.**

ENAMELED BOMBS IN CALORIMETRY. See Matignon, C. (this *Bibliography*, p. 208).

Markert, F. S.

FUNCTION OF MANGANESE DIOXIDE IN GROUND COAT. *Enamelist*, **3** [1], 26 (1925).—The effects of manganese dioxide in enamels are: (1) It gives good gloss to the enamel. (2) It gives a harder enamel. Enamels high in manganese dioxide may be fired much harder with less danger of overfiring than those low in manganese dioxide and higher in cobalt oxide. (3) It tends to reduce the coefficient of expansion of the glass in which it is used. (4) It is not as neat appearing a color as cobalt, but when used together with cobalt the color obtained is uniform and desirable in stove work. (5) There seems to be no difference in the adhesion of the ground coat to the steel between enamels using either manganese or cobalt alone or combinations of these two with other oxides. (6) It has no apparent effect on chipping. Some ideas of the amounts used in practical formula are:

Cobalt oxide (%)	Manganese dioxide (%)	Stynium (%)
1/4	1 1/2	3/4
3/4	2 1/4	
	3 1/2	
1 1/2		

Markert, F. S.

AIR AGITATION. *Enamelist*, **5** [1], 35 (1927).—A method of air agitation for ground coat dip tank is described.

Markert, F. S.

CHECKING FUEL OIL CONSUMPTION. *Enamelist*, **5** [2], 7 (1927).—Apparatus for making an accurate determination of the consumption of fuel oil is described.

***Markert, F. S.**

FUNCTION OF MANGANESE DIOXIDE IN GROUND-COAT ENAMELS. See Oesterle, G. (this *Bibliography*, p. 226).

Marschuetz, Oscar

REVERSIBLE ENAMELING CRADLE. U. S. Pat. 538,453, April 30, 1895—A reversible cradle for handling articles to be enameled, consisting of a bed part, composed of two end pieces, two side bars, and a bottom balance bar connecting the end pieces, and two shelf pieces, one at each end of the cradle bed, projecting inwardly from the top of the end pieces; and a frame part consisting of two end standards connected by a broad bottom piece, from the lower surface of which at its middle projects downward, a pivot post having its lower end rounded and a socket for receiving a spring pin in its side, the bed part swung loosely in the frame part on shafts bolted firmly at their inner ends to the end pieces of the bed parts, having bearings on the standards of the frame part and squared at their outer ends to receive a crank handle.

Maschinenb., **14**, p. 364.

NEW METHOD OF MANUFACTURE FOR ENAMELED IRONWARE. (*Rep. der Tech. Lit.*, p. 142 (1879–1881).)

Masing, G.

CAUSE OF INVERSE SEGREGATION. *Z. Metall.*, **17**, 251 (1925).—The phenomena which occur during cooling of a casting of an alloy are as follows: Crystallization of the primary dendrites starts at the surface of the mold, and these proceed to grow into the mass; as the temperature falls further, the dendrites shrink away from the sides of the mold, leaving hollow spaces which later, at the moment of expansion on solidification, are filled by the remaining liquid being forced into them. Thus, the outer layers of the ingot are richer in the constituent of lower melting point than the core. The conditions for the occurrence of this inverse segregation are: (1) a tendency for the primary crystals to grow in dendritic form; (2) a tendency for the formation of mixed crystals having zones of different composition; (3) a considerable difference in the composition of the crystals first formed and the remaining liquid. (*Ceram. Abs.*, **5**, 117 (1926); *Chem. and Ind.*, **44B**, 994 (1925).)

Mason, W.

MANUFACTURE OF ENAMELS. *Metal Ind.* (London), **28**, 525, 550.—A review. (*Chem. Abs.*, **20**, 2569 (1926).)

Matignon, C., and Marchal, G.

USE OF ENAMELED BOMBS IN CALORIMETRY. *Compt. rend.*, **172**, 921 (1921).—The HNO_3 produced in the explosion attacks the enamel and is neutralized by it. The loss of acid may lead to an error of $^1/_2\%$. It is rendered negligible by first treating the enamel for some hours with dilute acid. (*Jour. Amer. Ceram. Soc.* (Abs.), **4**, 1009 (1921); *Chem. and Ind.*, **40A**, 415 (1921).)

Mattenklott

ENAMELING OVEN. *Maschinenb.*, **30**, 13. (*Rep. der Tech. Lit.*, p. 103 (1894–1896).)

Mayer, A. E.

PECULIARITY OF SOME GLAZES. *Trans. Amer. Ceram. Soc.*, **11**, 369 (1909).—"Ropey" or settling glazes are set up with chemical reagents which neutralize alkalinity of finely-ground glaze. Viscosity increases with alkalinity, which increases with time of grinding.

Mayer, M., and Havas, B.

EXPANSION COEFFICIENT OF SHEET-IRON ENAMELS. *Chem. Ztg.*, **33**, 1314 (1909).—The coefficient of expansion of an enamel is a function of the chemical composition of the

enamel. Our present knowledge of the rôle played by the constituents of an enamel in determining the expansion coefficient is limited to qualitative facts and is expressed by the statement that the coefficient of expansion increases with increase in alkali content and decreases with rises in boric alkali content and decreases with rise in boric acid or silica. The function of the body enamel, it is commonly thought, is to equalize the variance between the expansion of a surface enamel and the iron plate. Experiments show that this cannot be the case because the body enamels have even smaller coefficient of expansion than surface enamels; their results show that surface enamels have coefficients of expansion about 25 to 28% smaller than those of iron. Grünwald claims that the value of body enamels lies in the fact that because of their content of cobalt oxide and borax their coefficients of expansion coincide with that of iron. The authors controvert this. Ost claims that by varying the content of borax in enamels an identical coefficient of expansion of the iron and enamels can be obtained. The authors also dispute this. Vondracek recommends the use of cryolite in enamels. The authors test this recommendation and conclude that enamels containing much cryolite become exceedingly brittle, do not possess a vitreous surface, and have extremely slight elasticity. For the determination of the coefficient of expansion, the Fuess method was adopted. The procedure is described in detail and the original article should be consulted for this. The coefficients of expansion of a number of enamels obtained by experiment are also published. Although the coefficient of the iron plate is 20 to 30% higher than that of enamel, the coefficient of expansion of the enameled object as a whole is 10% lower than the value given for iron alone, provided that only a thin layer of body enamel be used and that a surface enamel of great covering power be applied. Larger differences in expansion coefficient between the iron plate and the enamel account for the strains that frequently result in disintegration of the enameled object. (*Chem. Abs.*, **4**, 1092 (1910).)

Mayer, M., and Havas, B.

FUNCTION OF FLUORINE COMPOUNDS IN ENAMELS. *Sprechsaal*, **42**, 460 (1909); *Chem. Ztg.*, **33**, 758 (1909).—Fluorine is a good opacifier and permits the tin oxide to be decreased to 3% and still maintain excellent covering power. Analysis of raw and fused basic iron enamels proved that the fluorine is not completely expelled. The loss in fluorine in two ground enamels was 20.2 and 23.8% and in the cover enamel 11.85%. The lower loss in the latter case was due to the use of cryolite. The turbid effect of cryolite is very marked. It may partially replace the much-used oxide of tin. White enamels of extraordinary covering power were made from batches containing cryolite and only 3% of SnO_2. (*Chem. Abs.*, **3**, 2740, 3001 (1909); *Chem. and Ind.*, **28**, 835 (1909).)

Mayer, M., and Havas, B.

REACTIONS DURING THE FUSION OF IRON ENAMELS (CONTAINING FLUORINE). *Sprechsaal*, **44**, 6 (1911).—The amount of fluorine remaining in an enamel after smelting depends on the temperature and duration of firing, but principally on the nature of the compound in which the fluorine is introduced. The following were introduced into a glass of the same composition; in each case the percentage loss of fluorine is as follows:

	5% added, (%)	10% added, (%)
Fluorspar	33.8	33.6
Aluminum fluoride	37.4	36.1
Sodium fluoride	15.8	14.2
Cryolite	14.4	16.1

If boric acid is present additional loss may be caused by volatilization as boron trifluoride. (*Chem. Abs.*, **5**, 2163 (1911); *Chem. and Ind.*, **30**, 130 (1911).)

Mayer, M., and Havas, B.

COEFFICIENT OF THERMAL EXPANSION OF SHEET-IRON ENAMELS. *Sprechsaal*, **42**, 497 (1909).—Six different enamels were studied. The expansion was measured by means of the Fuess method, the results of which agree sufficiently with those obtained by optical methods. The specimens to be tested were 100 mm. long and 7 mm. thick. Since it was impossible to cast rods from the viscous enamels the specimens were obtained by drawing out the fused mass and cutting off when cold to the desired length. The coefficients of the following enamels were determined:

	Ground Enamel			Cover Enamel		Colorless glass
	1	2	3	1	2	
SiO_2	51.00	64.86	54.69	55.91	51.00	53.10
B_2O_3	15.79	9.46	12.47	6.96	6.80	14.33
AlF_3				3.95	6.92	
NaF				6.03	9.62	
CaF_2	5.44	3.67	4.68	1.73		4.58
CoO	0.25	0.21	0.31			
MnO	0.71	0.51	0.45			
Al_2O_3	7.86	6.45	8.83	10.30	8.85	7.01
CaO	1.51	1.01	1.26	0.54	1.77	1.20
K_2O	2.60	1.71	2.54	1.73	2.28	2.49
Na_2O	14.84	12.12	14.77	12.85	13.39	17.29
Cubical coeff. of exp. $\times 10^{-7}$	288.0	245.1	289.2	326.7	348.0	309.6

Sheet-iron specimens were likewise tested, the cubic coefficient of expansion of which varied from 384.6×10^{-7} to 420×10^{-7}. The different sheet irons did not vary among each other by more than 5 to 6%. Different methods of working the iron did not affect the expansion more than 3%. Finally the coefficient of enameled rods was determined. Sheet iron (coeff. 405×10^{-7}) was coated with ground enamel No. 3 (coeff. 289.2), and the resulting coefficient was found to be 402.9×10^{-7}. When coating this rod with cover enamel No. 1 + 6% SnO_2 (coeff. 300.3×10^{-7}), the resulting coefficient became 363.9×10^{-7}. It is evident therefore that the enamel is under great tension and that the ground coating must possess great elasticity. It is important that the enamels be applied as thin as possible. (*Chem. Abs.*, **3**, 2494 (1909); *Chem. and Ind.*, **28**, 1199 (1909).)

Mayer, M., and Havas, B.

FUNCTION OF GROUND ENAMEL. *Sprechsaal*, **43**, 727 (1910).—It was shown that iron reduces tin oxide to tin. Covering enamel applied direct upon the iron results in dark discolorations. Reduction of PbO to Pb is also observed. Cover enamels containing TiO_2, titanates, or ZrO_2 as opacifiers resulted in a faultless surface, but flaked off. The cobalt silicate in the ground coat is probably reduced to a low stage of oxidation as is indicated by the change of the blue color to green. (*Chem. Abs.*, **5**, 1981 (1911); *Chem. and Ind.*, **29**, 1455 (1910).)

Mayer, M., and Havas, B.

COEFFICIENT OF EXPANSION OF ENAMELS AND THEIR CHEMICAL COMPOSITION. *Sprechsaal*, **44**, 188, 207, 220 (1911).—The coefficient of expansion was first determined for a number of materials according to the method of FUESS. The results were compared with those of Winkelmann and Schott. The values are expressed in terms of the cubical coefficient 3α per degree in mm. 10^{-7}. (1) Values of Mayer and Havas: Na_3AlF_6, 7.4; NaF, 7.4; ThO_2, 6.3; Cr_2O_3, 5.1; BeO, 4.7; CoO, 4.4; AlF_3, 4.4; CeO_2, 4.2; PbO, 4.2; TiO_2, 4.1; FeO, 4.0; NiO, 4.0; Sb_2O_3, 3.6; CaF_2, 2.5; MnO, 2.2; CuO, 2.2; ZrO_2, 2.1; SnO_2, 2.1. (2) Values of Winkelmann and Schott: PbO, 3.00; Na_2O, 10.00; K_2O, 8.5; CaO, 5.0; Al_2O_3, 5.0; ZnO, 1.8; B_2O_3, 0.1; SiO_2, 0.8; BaO, 3.0; As_2S_3, 2.0; Li_2O, 2.0; P_2O_5, 2.0; MgO, 0.1. These results were checked with the re-

sults obtained with enamels of known composition in which the error seemed to vary from −4.9 to +4.0%. (*Chem. Abs.*, **5**, 2163 (1911); *Chem. and Ind.*, **30**, 543 (1911).)

Mayer, M., and Havas, B.

WHITE OPAQUE ENAMEL. U. S. Pat. 1,104,266, July 21, 1914.—Contains spinel and preferably small amounts of zirconium, titanium, stannic, or silicon oxide as opaquing material. The formula for the spinel is given as $MgO \cdot Al_2O_3$ or $ZnO \cdot Al_2O_3$. (*Chem. Abs.*, **8**, 3106 (1914); *Chem. and Ind.*, **33**, 921 (1914).)

Mayer, M., and Havas, B.

OPAQUE WHITE ENAMELS. U. S. Pat. 1,220,253, Mar. 27, 1917.—A mixture of titanium oxide and zirconium oxide is used for opaquing white enamel, such as formed from borax 20.5, feldspar 30.4, quartz 19.7, soda 8, KNO_3 2.7, cryolite 16, and enamel clay 7 parts. (*Chem. Abs.*, **11**, 1735 (1917); *Chem. and Ind.*, **36**, 504 (1917).)

McBride, P. B.

INDUSTRY'S NEWEST AND FINEST PLANT. *Enamelist*, **5** [1], 46 (1927).—Description and illustrations of The Louisville Enameled Products Co.

McCaughey, W. J.

EXAMINATION OF COMMERCIAL FELDSPAR. *Trans. Amer. Ceram. Soc.*, **15**, 381 (1913).—For microscopic examination the sample is crushed to 100-mesh. About 3 mg. is taken on a knife point and placed on a slide. The sample is mixed with clove oil (n 1.527, between potash feldspars and albite). Distinction by n is made by Schroeder, Van der Kolk or Becke methods. Counts should be made on not less than 75 grains. Further distinctions are made in cleavage, extinction, birefringence, kind and amounts of twinning, etc. Impurities other than different feldspar and quartz may similarly be recognized and estimated quantitatively. (*Chem. Abs.*, **8**, 798 (1914).)

McClaire, J. P.

ELECTROLYTIC REMOVAL OF RUST. *Chem. Trade J. and Chem. Eng.*, **74**, 33 (1924).—The rusty articles are used as cathodes in a bath containing sodium hydroxide, sodium carbonate, sodium sulphate, and sodium cyanide in solution. A current density of 30 to 140 amperes per sq. ft. causes a rapid evolution of hydrogen, which reduces the rust in a few minutes. The process has been tried successfully on a commercial scale in England for reconditioning war material. (*Ceram. Abs.*, **3**, 240 (1924).)

McCourt, C. D., and Wilson, H. F.

APPARATUS FOR USE IN ENAMELING IRON CASTINGS, ETC. British Pat. 2448, Jan. 31, 1911.—In enameling iron castings with poisonous or objectionable powders, the dusting operations are conducted in a cabinet, provided in front with a sliding door, in which openings are made for the operator's hands. Means are also provided for supporting and turning the casting inside the cabinet, and for tilting it by means of a fork which can be inserted through a notched slot. The dusting device may be either operated by hand inside the cabinet, or driven mechanically by a motor, and can be started or stopped at will. (*Chem. and Ind.*, **31**, 231 (1912).)

McDowell, Samuel J.

EFFECT OF VARIOUS SODIUM SILICATES AND OTHER ELECTROLYTES ON CLAY SLIPS. *Jour. Amer. Ceram. Soc.*, **10**, 225 (1927).—Different brands of sodium silicate vary 250% in their soda to silica ratio. Four silicates with ratios from 1:1.8 to 1:4 were added on a basis of per cent Na_2O to slips of six clays commonly used in the whiteware industry. Rate of flow, hydrogen-ion concentration, and settling behavior were studied. Maxi-

mum rate of flow was produced in each case while the slip was acid. Those silicates high in silica were the most potent in their effect on rate of flow for a given amount of Na_2O. The effect was also more pronounced than that of NaOH, Na_2CO_3, or silica solution which were used as comparisons. Possible explanations of the mechanism or deflocculation are discussed to explain the results. (*Ceram. Abs.*, **6**, 228 (1927); *Chem. Abs.*, **21**, 1875 (1927); *Chem. and Ind.*, **46B**, 677 (1927).)

McFadon, E. O.

OBSERVATIONS ON OXIDES. *Enamelist*, **5** [1], 58 (1927).—Oxide manufacturers have better facilities for preliminary work in color matching. Difference in frit and furnace conditions may cause decided variation in color. Some oxides used in steel enamels produce entirely different results when used in cast iron enamel.

McGowan, J. F.

ENAMELED WARE AND ORNAMENTING THEREOF. U. S. Pat. 596,942, Jan. 4, 1898.—The article of enameled metalware, and process for producing it, having a graduated clouded or shaded ornamented enameled surface consisting of a foundation coating of enameling material and an outer contrasting partial coating of enameling material which was of greater fluidity than the foundation coating, the two coats commingled together.

***McGowan, James F.**

ORNAMENTAL ENAMELWARE. See Hughes, Josiah (this *Bibliography*, p. 157).

McIntyre, Glenn H.

PURE SCIENCE RESEARCH AND THE ENAMELING INDUSTRY. *Enamelist*, **5** [1], 38 (1927).—The value of research to the industry.

McLean, W. A.

DESIGN AND OPERATION OF A COLLOID MILL. *Chem. Met. Eng.*, **30**, 675 (1924).—Describes a mill invented by F. J. E.China, of London, and used commercially for a year. The mill will disintegrate solid, plastic, or liquid masses into colloidal particles whose dimensions are one micron or less in diameter. In design the mill consists of a rotor with a smooth face upon the frustrum of a cone, turning within the similar surface of a stator, the whole enclosed in a casing. Thus, there are two variables in operating the mill; the clearance between the rotor and the stator, which may be from 0.002 inch upward, and the speed of rotation, which may vary from 1000 to 20,000 r. p. m. Solids must first be ground to about 150-mesh and suspended in a liquid medium. The centrifugal action of the rotor sucks the liquid through the inlet at the bottom of the mill, through the space between rotor and stator, and out through a discharge above the rotor. From 1 to 2.5 tons of feldspar per hour may be ground to colloidal fineness, with the passage of 3.5 to 5 tons of water medium. A discussion of the disruptive forces used by the mill is given, together with figures on power consumption. (*Ceram. Abs.*, **3**, 248 (1924).)

***Mead, A. A.**

ENAMELING THE INTERIOR OF PIPES. See Lambert, W. (this *Bibliography*, p. 184).

ENAMELING OR GLAZING METAL ARTICLES. See Lambert, W. (this *Bibliography*, p. 184).

Meadows, Albert

FIRST CONTINUOUS ENAMEL PLANT. *Enamelist*, **2** [5], 18 (1925).—Description of the new enamel shop of the Detroit Vapor Stove Co. Work is carried progressively through the solution of five tanks and through a drying room. This conveyer ends near

the ground-coat tub. A second conveyer carries dipped work over a drip tray into a steam-heated drying room and finally delivers it to the ground coat firing furnace. The work travels through a circular furnace having a rotating hearth. Work makes one revolution, is placed on conveyer going to spraying booth, thence to drying room, and finally delivered at first white firing furnace, which is similar to ground-coat furnace but operates at lower temperature.

Mehling, C. W.

THREE DAYS MANUFACTURING TIME CUT TO TWO HOURS IN SUPERENAMEL PLANT. *Ceram. Ind.*, **7**, 229 (1926).—A description of equipment used at the enameling plant of the American Radiator Co. Three electric rotary furnaces are used. The ground coat furnace which looks like a large pie with a piece cut out of it, is 75 ft. in circumference. An arc suspended by an angle of about 45° covers the space removed. This is used for loading and unloading the ware. The firing chamber in the furnace is 24 in. wide, 60 in. high, and the length of travel through the furnace is 54 ft. The first zone of the furnace has a heat of about 1400°F, after which the ware gradually passes into the 1600° zone, and then into the zone of about 1200°F. This keeps the ware from warping during the entire firing and also eliminates pin marks. A layout is given which shows graphically the route taken by the ware at this plant. (*Ceram. Abs.*, **5**, 344 (1926).)

Mehling, C. W.

ENAMELERS SAVE WITH ELECTRICITY. *Ceram. Ind.*, **8**, 447 (1927.)—Points out advantages of electric furnaces. (*Ceram. Abs.*, **6**, 213 (1927).)

Mehling, C. W.

DE-ENAMELING. *Enamelist*, **2** [2], 8 (1924).—Ware de-enameled:

	Sq. ft.		
Tops, 4 section	720.8	Cost:	
Tops, 5 section	456	Acid 755 lbs. at 16¢	$120.00
Tops, 6 section	625.6	Labor 20 hr. at 50¢	10.00
Tops, 7 section	223.6	Overhead 100%	10.00
Sides, 4 section	82.5		
Sides, 5 section	33.5		$140.00
Fronts	1282.5	Cost per sq. ft. $0.0317421	
Backs	697.5	100% overhead $0.03413	
Total	4122		

Mixture for de-enamel	Lbs.
HF	600
HCl	25
H_2O	2500

Life of solution from 36 to 40 hours. Temperature of solution 160 to 180°F. Time for stripping enamel, 1 to 2 hours.

Mehling, C. W.

CLEANING IRON AND STEEL FOR ENAMELING. *Fuels and Fur.*, **3**, 132 (1925).—A rapid process for cleaning sheet iron and steel for japanning and enameling consists in dipping in a Monel metal basket into 3 solutions. First a boiling Wyandotte solution for 15 min., then acid for 10 min. and finally a boiling solution of salsoda, for a few minutes, rinsing in warm water between each solution. Strength of first solution is 6 oz. of Wyandotte per gallon of water, second, 2 parts water to 1 part muriatic acid, and third, 100 lbs. salsoda to 1000 gallons of water. Two men can clean about 24,000 sq. ft. of surface per 9 hr. day and the cost is 0.008¢ per sq. ft. including overhead. (*Ceram. Abs.*, **4**, 183 (1925).)

•Mehling, C. W.

ELECTRIC HEAT RAISES ENAMELING OUTPUT. See Carpenter, J. W. (this *Bibliography*, p. 48).

Mehling, C. W., and Carpenter, Jas. W.

ELECTRIC VITREOUS ENAMELING OVEN. *Jour. Amer. Ceram. Soc.*, **4**, 271 (1921).—In marked contrast with the oil, coal, and gas furnaces, the electric furnace eliminates damaged ware and makes possible the utilization of the entire heating space. Its initial cost and the fuel costs are double those of the older types but it admits 25% increase in weight per charge and 30% in charges per hour. Details of construction and operation are given. The electrical equipment is explained together with the methods of temperature record and control. With an initial cost of $8000, the cost of the electrical power has been $2 per hour for a 10-hour day which would be reduced to $1.56 per hour for a 24-hour day. With a production of 900 pounds of ware per hour the enamel finish is more satisfactory than with the older types of furnaces. Preheating chambers and double-end operation are suggested. (*Chem. Abs.*, **15**, 2702 (1921); *Chem. and Ind.*, **40A**, 390 (1921).)

•Meirling, Th.

USE OF CAST-IRON IN THE CONSTRUCTION OF APPARATUS. See Denecke, W. (this *Bibliography*, p. 93).

Mellor, J. W.

PLASTICITY OF CLAYS. *Trans. Faraday Soc.*, May 31 (1921).—M. discusses the theory of the plasticity of clay from the standpoint of physical and chemical properties and also the relative value of the factors involved in proposed formulas for plasticity determination. An apparatus is described for measuring plasticity by means of forming spheres of standard size and applying pressure until outside cracks appear. In consideration of plasticity, he discusses grain size of clay, effect of acids, alkalis, and salts on sedimentation, and the action of colloidal matter. Directions are given for isolating colloidal clay by suspension and evaporation. (*Chem. Abs.*, **15**, 3376 (1921).)

Melzer, H.

ANTIMONY WHITE ENAMEL. *Keram. Rundschau*, **34**, 801 (1926); *Chem. Zentr.*, **1**, 785 (1927).—The mixture for producing the enamel must be easily fusible as compared with the foundation; the enamel must have the correct coefficient of expansion, high tensile strength, and good turbidity, and must contain not more than 8% Sb_2O_3 and 7% Al_2O_3, while the remaining constituents must be carefully selected. (*Ceram. Abs.*, **6**, 569 (1927); *Chem. and Ind.*, **46B**, 677 (1927).)

•Menne, L. H.

PAPERS ON ENAMELING BEFORE THE CHICAGO SECTION, AMERICAN CERAMIC SOCIETY. "The Enameling of Cast Iron." See *Chem. Met. Eng.* (this *Bibliography*, p. 65).

Mernagh, L. R.

ENAMELED STEEL INDUSTRY. *Enamelist*, **2** [9], 32 (1925).—General description of the English practice.

Mernagh, L. R.

ANTIMONY AS A CONSTITUENT OF ENAMELS. *Chem. and Ind.*, **45**, 815 (1926).—Sb compounds employed in enamels are primarily Sb_2O_4 and to a less extent $NaSbO_3$, the latter costing twice as much as the oxide, and being less effective. Lead is barred from white enamels containing Sb owing to the production of Naples yellow. The opacifier

is usually fritted with the enamel, though losses result through volatilization. This renders it more refractory, but brings its expansion nearer to that of iron. A further advantage is that by increasing the viscosity of the batch, it guards against devitrification. Like other opacifiers, the best result is obtained with minimum heat treatment. From the methods of preparation, Sb_2O_4 is likely to contain S, and $NaSbO_3$ to contain S, chloride, and sulphate, any of which will destroy gloss. M. does not agree with Grünwald that above 3 to 4% Sb renders an enamel of less covering power and more soapy and defective, nor does he accept G.'s dictum that the Sb becomes combined as silicate. He regards the opacifying effect as due to finely distributed alkali antimonates. He then declares the one real reason why the use of Sb is not universal in hollow ware, *viz.*, the question of toxicity. There are no regulations forbidding its employment in England, Holland, or the United States. The position in Germany is obscure, but Sb ware is certainly exported from Germany. Difference of opinion on toxicity is due to failure to distinguish between soluble and insoluble compounds, and between trivalent and pentavalent. Tartar emetic is peculiarly poisonous because it contains the stibonyl group, but if antimonates are to be excluded because tartar emetic is toxic, tin oxide should be condemned because soluble tin salts are toxic. The indirect evidence includes the fact that factories making Sb oxides have had men working for years without respirators, and no ill effects have been noted. M. then recounts his own experimental work after referring to Svagr's recent investigation (*Chem. Listy*, **20**, 21–24 (1926)), S. being of opinion that no ill effects have resulted from the prolonged use of antimony enamel. M. selected as basis a good commercial white enamel, above the average in SiO_2. Frits were made with increasing per cent, 1 to 10 of (*a*) Sb_2O_4, (*b*) $NaSbO_3$. Pie dishes, $10^1/_4$ in. diameter, in triplicate, were enameled, the result in all cases being an excellent glossy finish. In these, 10% solutions of citric, acetic, and tartaric acids were kept gently boiling for an hour, the original volume being periodically restored with water. The acids were then cooled, nearly neutralized with KOH, rochelle salt was added, then excess $NaHCO_3$, and the liquid titrated against $N/50$ I. In all cases the gloss was destroyed by the treatment, the highest loss being 0.6 mg. Sb per sq. decimeter (whether Sb_2O_4 or $NaSbO_3$ enamel not stated). Lower strength acids and longer periods of action did not increase solubility. An enamel made from Rickmann's formula (*Sprechsaal*, **45**, 115 (1912)) under the same treatment with 10% tartaric lost 31 mg. Sb per sq. dm. M. concludes that toxicity comes from As, and that pure Sb compounds in well-fritted enamels are absolutely safe. (*Ceram. Abs.*, **6**, 50 (1927); *Chem. Abs.*, **21**, 634 (1927).)

Metal Work, **82**, 410 (1914).

DON'TS RELATIVE TO ENAMELED IRONWARE.—Article deals with the handling of this class of goods. Illustrations are given showing the common causes for breakage of sanitary fixtures.

Metal Work, **86**, 273 (1916).

CALIFORNIA SANITARY ENAMELED WARE PLANT.—Description of the processes of manufacture of bath tubs and lavatories followed by the Pacific Sanitary Mfg. Co., Richmond, Calif. No data.

Meurer, N.

ENAMELING AND GLAZING. German Pat. 347,229, April 3, 1921.—The enamel is applied in the form of paste; dried, and then fused by means of a reducing flame fed with "mixed gas" under pressure, the flame being moved about so that air has momentary access to the parts to be enameled. The resulting enamels are resistant to sudden changes in temperature and to mechanical shock, and the use of a kiln or oven and of dusty enamels is avoided. (*Chem. and Ind.*, **41A**, 254 (1922).)

Meurer, N.

ENAMELING AND GLAZING METALLIC OBJECTS. German Pat. 347,496, April 3, 1921.—The objects are coated with a film of copper, nickel, cobalt, or other suitable metal by spraying. The enamel containing easily reducible metallic oxides attaches itself very strongly to this film. (*Chem. and Ind.*, **41A**, 295 (1922).)

Meurer, N.

ENAMELING. British Pat. 179,216, Nov. 27, 1920.—In enameling metal, ceramic, or heat-resisting articles by spraying enamels, glass, or mixtures rich in quartz on to the articles by means of gases under pressure, the surface of the article is heated by the spraying jet to the fusing temperature of the coating material, and the flame that effects the melting and heating has a reducing action to prevent oxidation. A suitable construction is specified. (*Ceram. Abs.*, **2**, 65 (1923); *Chem. Abs.*, **16**, 3372 (1922); *Chem. and Ind.*, **41A**, 502 (1922).)

Meyer, A.

ENAMEL. British Pat. 2155, Jan. 27, 1913.—An enamel composed of 2 parts of silicic acid (quartz), 1 aluminum silicate, 0.25 part of minium (Pb_3O_4), 0.15 alkali (hydrated borate of soda), and 0.015 ground rutile is applied over the first vitrified anti-oxide layer described in 3547 (1912) and may be followed by more fusible decorative layers and a final transparent coating of low fusing point. (*Chem. Abs.*, **8**, 2611 (1914).)

Meyer, A.

ENAMELING. British Pat. 2279, Jan. 28, 1913.—Coats of enamel of increasing fusibility are applied over the anti-oxide layer described in 3547 (1912). (*Chem. Abs.*, **8**, 2612 (1914).)

Meyer, A.

ENAMELING OR GLAZING PLATES OF IRON, STEEL, ETC. German Pat. 266,161 July 9, 1911.—Process of enameling or glazing plates of iron, steel, etc. (*Chem. Abs.*, **8**, 809 (1914).)

Meyer, A.

ENAMELED OR GLAZED PLATES OF IRON OR STEEL. German Pat. 272,355, July 9, 1911.—The plates are cleaned carefully as in an acid bath with subsequent scouring with sand, and then provided on the reverse side with a light glaze resisting oxidation, whereupon they are exposed for 2 to 3 minutes in the fire to a temperature of about 900°, whereby the bubbles are driven out and subsequent enameling shows no bubbles. The plate is rolled then under great pressure to take the elasticity, and, before enameling, the front surface is subjected to the action of a strong blast of Carborundum in order to roughen the surface and increase the adhesion of the subsequently applied enamel. (*Chem. Abs.*, **8**, 2612 (1914).)

Meyer, A.

GLAZED OR ENAMELED SHEETS OF IRON, STEEL, ETC. German Pat. 325,673, Mar. 15, 1918.—The ground coat of enamel is overlaid with successive opaque layers of enamel composed of silica, aluminum silicate, lead oxide, and an alkali such as sodium borate. Powdered rutile in variable proportion is added to successive layers, in order to increase or diminish their respective plasticities. (*Chem. and Ind.*, **39A**, 821 (1920).)

Meyercord, George R.

DECORATING ENAMELED METAL. U. S. Pat. 1,033,821, July 30, 1912.—The process of decorating enameled metal which consists in placing on the enameled surface a coloring

material held together by a binder which will vaporize at least partly at a comparatively low temperature, heating at a low temperature, and then suddenly applying an intense heat to flux the enamel and coloring material. (*Chem. Abs.*, **6**, 2679 (1912).)

Michel, R.

IRIDESCENT PEARL PRODUCTS. French Pat. 455,064, May 11, 1912.—In the manufacture of iridescent pearl products by heating and treating with vapors of $TiCl_4$, the metal vapors are applied before the finished article has cooled. (*Chem. Abs.*, **8**, 997 (1914).)

Michel, R.

IRIDESCENT ENAMEL. French Pat. (addition 17,326 to 455,064), Feb. 7, 1913.—Glassware or enamelware, immediately after production, is exposed at a suitable temperature to metal bromide vapors for the production of an iridescent enamel. (*Chem. Abs.*, **8**, 2046 (1914).)

Miles, F. W.

ENAMELING MACHINE. U. S. Pat. 1,146,507, July 13, 1915.—The combination of a hood, a conveyer passing therethrough, a plurality of spray-housing extensions formed on the hood, and means for spraying coating material located in each of the extensions.

Miller, John A.

ENAMELING OVEN. U. S. Pat. 1,555,304, Sept. 29, 1925.—In a heat-treating device, a chamber having an entrance leading thereinto, and a closure for the entrance, heating means located within the chamber, an air-intake device located within the chamber in direct communication with the exterior atmosphere through an opening provided in the wall of the chamber and discharging directly into the interior of the chamber adjacent the lower portion thereof, the chamber being provided in one of its walls adjacent the lower end thereof with a ventilation opening communicating with the air intake device, and a ventilating conduit communicating with the opening and extending upwardly therefrom. (*Ceram. Abs.*, **4**, 332 (1925).)

Miller, William T. W.

BALL AND TUBE MILL LINERS. *Eng. Min. J. Press*, **118**, 613 (1924).—A discussion is given on the linings used in ball and tube mills. In the early days flint pebbles were largely used as the grinding media and the lining of the mill was also made of silica in either natural or artificial blocks. In industries, such as the pottery trade, the silex lining is still in use but such instances are now exceptional, and the use of alloy steel or iron linings has become the general practice. (*Ceram. Abs.*, **4**, 83 (1925).)

Milligan, H. C.

ENAMELING IRONWARE. U. S. Pat. 296,206, April 1, 1884.—The process of enameling iron with a thin enamel, so as to produce a surface of uniform color and free from the usual spots or mottles, which consists in adding to the paste, after it has been prepared in any of the usual and well-known ways, an additional supply of alkali solution sufficient to neutralize any acid which may be present in the paste, and then applying the paste to the chemically-clean surface of the iron and fusing the same in a muffle, substantially as herein set forth.

Milligan, Henry C.

PROCESS OF ENAMELING STEELWARE. U. S. Pat. 762,547, June 14, 1904.—Steel is pickled, washed, dried, immersed in an acid solution and coated while wet with alkaline liquid enamel, dried, and fused.

Miner, E. G.

ENAMEL-LINED APPARATUS. *Chem. Met. Eng.*, **28**, 687 (1923).—Enameled steel tanks will withstand very high pressures as well as possess noncorrosive and acid-resisting properties. Coördinated efforts have resulted in standardization of units as follows: a standard jacketed still with reducing ell, for the distillation of essential oils and acids, the reduction of fats, etc., a standard jacketed closed mixing tank with enameled steel agitator, an open evaporating or crystallizing pan, a standard utility pot, and special equipment. (*Ceram. Abs.*, **3**, 280 (1924).)

Miniter, J. R.

EFFICIENT INDUSTRIAL ILLUMINATION. *Enamelist*, **1** [10], 16 (1924).—General recommendations for satisfactory illumination: (1) light should be of sufficient intensity upon the working surface; (2) light should be so directed that all glare will be eliminated; and (3) there should be a diffusion of illumination to prevent sharp light contrast above and below reflector. Standard R. L. M. dome most completely meets the demand of general overhead lighting. For work that is fine and intricate a deep bowl reflector is used to supplement the overhead illumination with localized lighting. Standard angle reflector is used where an overhead system is not permitted.

Minneman, J.

ART ENAMELING ON METAL. *Trans. Amer. Ceram. Soc.*, **13**, 514 (1911).—Methods and results of investigation. Comparison of effect of varying different constituents. (*Chem. Abs.*, **5**, 3890 (1911); *Chem. and Ind.*, **30**, 1386 (1911).)

Minneman, J.

COMMERCIAL TESTING OF FELDSPAR. *Trans. Amer. Ceram. Soc.*, **15**, 101 (1913).—Samples from each car are tested for: (*a*) residue on 120-, 150-, and 200-mesh, (*b*) fusibility alone and with 15 to 20% flint as compared with standard feldspar, (*c*) color and freedom from black specks in the fused cones. Flint is added in the tests because variation of 5 to 15% quartz in the feldspar changes fusibility but little. If exaggerated by an addition of 15 to 20% flint the variations are evident. *Discussion:* Watts held that tests should include mixtures with standard amounts of clay and flint that the various feldspars fuse at cones 7 to 8 and not slightly below cone 6 as reported by Minneman. (*Chem. Abs.*, **8**, 798 (1914).)

Minton, R. H.

SUBSTITUTES FOR TIN OXIDE IN GLAZES. *Jour. Amer. Ceram. Soc.*, **3**, 6 (1920).—Twelve different substitutes were used in four different glazes including (1) raw lead glaze at cone 02, (2) fritted wall-tile glaze at cone 02, (3) terra cotta raw glaze at cone 6, and (4) raw porcelain glaze at cone 9. The substitutes tried were: (1) terrar, (2) (3) (4) ZrO_2 (3 sources), (5) CaF_2, (6) Sb_2O_3, (7) $Al(OH)_3$, (8) Na_3AlF_6, (9) leukonin, (10) stannolite, (11) phosphorite, (12) lithopone. The conclusions are: (1) ZnO assists greatly in producing opacity with SnO_2 and with the substitutes. (2) BaO exerts a marked influence. (3) Clay content has less influence on opacity than do ZnO and BaO. (4) A glaze of the type of the terra cotta raw glaze is most favorable to opacity whether produced by SnO_2 or by substitutes. (5) Where they can be used leukonin and Sb_2O_3 are cheaper than SnO_2. ZrO_2 is the best substitute for SnO_2 but it is expensive. (*Chem. Abs.*, **14**, 1741 (1920); *Chem. and Ind.*, **39A**, 366 (1920).)

Mitchell, H. J., and Twells, Robert

HOW MUCH DOES DIRT COLLECT FROM DIVIDENDS? *Ceram. Ind.*, **9**, 41 (1927).—Neatness and orderliness have been found by the Champion Porcelain Co. to lift morale

and increase output. Simple devices that aid in keeping clean are described. A flow sheet showing the progress of a batch of Champion Porcelain spark plug body from the ball mills to the aging cellar is given. (*Ceram. Abs.*, **6**, 411 (1927).)

Miyaguchi, Takeo

METHOD OF CEMENTATION OF BORON INTO THE SURFACE OF IRON OR STEEL. U. S. Pat. 1,472,850, Nov. 6, 1923.—A method of cementation of boron into the surface of iron or steel comprises covering the desired surface of the iron or steel with a mixture of carbon powder and boron oxide or compound and heating it at from 800 to 900°C in a reducing atmosphere. (British Pat. 193,917, Nov. 3, 1921.) U. S. Pat. 1,472,851, Nov. 6, 1923.—A method for the cementation of boron into the surface of iron, or steel, comprises placing the iron or steel within a closed furnace, covering the portion desired to be cemented with a finely powdered boron containing material shielding the remaining portion with iron plate, iron powder, clay, etc., to prevent cementation action of boron, and heating the iron or steel for a considerable period, at from 800 to 900°C in the presence of chlorine gas (British Pat. 193,918, Nov. 3, 1921). (*Ceram. Abs.*, **3**, 6 (1924).)

Moecker, H., Jr.

ENAMELING. U. S. Pat. 1,503,991, Aug. 5, 1924.—In enameling stoves or other articles, wet patterns are applied to the surface before application of the enamel. The enamel is then applied and allowed to dry and the dry patterns are then removed to effect a removal of enamel from desired portions represented by the patterns, prior to fusing of the enamel. (*Ceram. Abs.*, **3**, 280 (1924); *Chem. Abs.*, **18**, 3264 (1924).)

Monier-Williams, G. W.

SOLUBILITY OF GLAZES AND ENAMELS USED IN COOKING. *Analyst*, **50**, 133; *Ceram. Ind.*, **5**, 440 (1925).—Some cheap enameled ware (mostly from France) was found to contain lead, which was dissolved appreciably by dilute citric acid solutions. In several cases some enameled hollowware was attacked by dilute citric acid and considerable B_2O_3 as well as aluminum and iron was dissolved from the glaze. (*Chem. Abs.*, **19**, 2869 (1925).)

Mori, S.

EFFECT OF VARIATION IN COMPOSITION OF GROUND-COAT ENAMEL ON ITS ADHERENCE TO IRON. *Jour. Jap. Ceram. Assn.*, **343**, 233 (1921); *ibid.*, **344**, 272 (1921).—Adherence of ground coat to iron was measured by impact test, using soft-steel sheets, gage No. 28 and 1 in. x 2.5 in. large, as test pieces. An enamel which had proved to be very good in practice was taken as the basis of experiments. Its formula was 0.455 Na_2O, 0.245 K_2O, 0.232 CaO, 0.016 CoO, 0.955 MnO, 0.198 Al_2O_3, 1.490 SiO_2, 0.455 B_2O_3, 0.200 F_2. Now the content of silica, boric acid, alumina, soda, potash, or lime was varied within ranges as follows: 1.266 to 1.754 SiO_2; 0.455 to 3.200 B_2O_3; 0.198 to 0.227 Al_2O_3; 0.426 to 0.561 Na_2O; 0.214 to 0.306 K_2O and 0.136 to 0.544 CaO. Conclusions are: (1) any increase in silica or boric acid reduces the resistance to chipping; (2) the resistance of enamel to chipping increases with the addition of alumina; (3) adherence of ground coat is strengthened by the increase of soda, potash, or lime up to a certain degree beyond which the effect is reversed. (*Ceram. Abs.*, **1**, 293 (1922); *Chem. Abs.*, **16**, 3534 (1922).)

Mori, S.

VEHICLES USED IN ENAMELING SLIPS. *Jour. Jap. Ceram. Assn.*, **352**, 630 (1921).—Explanations and discussions on the reason why enamelers use vehicles or stiffening

materials, the rôle of clay in enameling slips, theories of deflocculation of the slip, and the action of vehicles on the slip are given. The effect of various vehicles on the viscosity of an enameling slip is shown with diagrams. A ground-coat enamel with formula as 0.455 Na_2O, 0.245 K_2O, 0.232 CaO, 0.016 CoO, 0.0055 MnO, 0.198 Al_2O_3, 1.49 SiO_2, 0.49 B_2O_3, 0.20 F_2, ground with 5% washed Gairome (plastic kaolin) and 35% of water, was used for the experiments. The amounts of vehicles required for one liter of slip in making its viscosity most suitable for working were as follows: sodium chloride 4.68 g., barium chloride 0.732 g., aluminum chloride 0.3 g., sodium carbonate 8.4 g., ammonium carbonate 0.9 g., borax 1.08 g., or brine 4 cc. The effect of vehicle diminishes with the lapse of time. Concluding from the results, M. recommends: (1) the use of least water, (2) the removal of water on storing slips, (3) when the use of vehicle is needed, borax, ammonium carbonate, or soda ash for ground coat, barium chloride or soda ash for cover coat, and aluminum chloride or calcined magnesium for soluble enamels as semifused ground coat of cast-iron ware, and (4) the use of stiffened slip within a few hours. (*Ceram. Abs.*, **1**, 293 (1922); *Chem. Abs.*, **16**, 3535 (1922).)

***Morimbau**

ENAMEL FOR VARIOUS METALS. See Durand (this *Bibliography*, p. 100).

***Moskowitz, M.**

COMPARISON OF THE VARIOUS CORN PRODUCT STARCHES AS SHOWN BY THE BINGHAM-GREENE PLASTOMETER. See Porst, C. E. G. (this *Bibliography*, p. 236).

Mottoni

ENAMELING CAST-IRON VESSELS.

Masch.-Constr., pp. 182, 197, 214, and 229 (1868). (*Rep. der Tech. Lit.*, p. 306 (1854–1868).)

Mulvaney, H. A.

ELECTRICITY VS. OIL. *Enamelist*, **3** [8], 31 (1926).—Taken from article in *Journal of Electricity* by M. The following operation data is given:

Oil consumed per 24 hr. operation of tub furnace	11 bbl.
Oil consumed per 24 hr. for atomizing	2.5 bbl.
Total consumption for 24-hr. period	13.5 bbl.
Oil consumed in 25 working days per month	337.5 bbl.
Oil consumed in 4 Sundays per month	32 bbl.
Total oil consumed per month	369.5 bbl.
Cost of oil per month ($1.40 per bbl.)	$517.30
Maintenance and depreciation	150.00
Cost due to warpage per month	60.00
Total operating cost per month	$727.30

Based on a production of 57 tubs per 24 hours, and figuring 25 working days, a production of 1425 tubs per month is secured from the muffle oil furnace at a cost of 51¢ per tub. Average monthly electric energy consumption equals 133,000 kw.-hr.

Cost of electric energy, 133,000 × $0.008	$1064.00
Maintenance and depreciation	37.50
Total operating cost per month	$1101.50

Based on a production of 96 tubs per 24 hours, there is a monthly production of 2400 tubs from the electric furnace, at a cost of 45.8¢ per tub.

***Munroe, L. J.**

ZIRCONIA IN ENAMELS (Discussion.) *Bull. Amer. Ceram. Soc.* (see this *Bibliography*, p. 41).

***Murray, H. A.**

COMBINED VISCOMETER AND PLASTOMETER. See Bingham, E. C. (this *Bibliography*, p. 24).

Musiol, C.

FLUORIDE ENAMELS. *Chimie et ind.*, **9**, 872 (1923).—A mathematical criticism of the theories of Vogt, Grünwald, and Mayer and Havas (*Sprechsaal*, 1911, No. 1) based on the analyses published by these authors. It is shown that F is not volatilized as SiF_4, that when B_2O_3 is present F is probably volatilized as BF_3 (this would require to be confirmed by analysis of the gases evolved), and that Mayer and Havas' results abound in errors, either clerical or analytical. A method is given for calculating the composition of the enamel from that of the initial mixture. Seger's formula is worse than useless. The relationship between the various constituents should be studied by means of the centesimal molecular composition. (*Ceram. Abs.*, **2**, 242 (1923); *Chem. Abs.*, **17**, 3080 (1923).)

Musiol, C.

ENAMELING SHEET-IRON AND CAST-IRON ARTICLES BY MEANS OF ENAMELS FREE FROM BORIC ACID AND COMPOSED OF SILICATES OF ALUMINUM, SODA, AND LIME, CONTAINING FLUORINE. French Pat. 473,395, June 12, 1914.—The enamels used, like ordinary bright and colored glazes, are free from boric acid and consist of a vehicle of silicate of alumina, soda, and lime mixed with fluorides; the usual coloring and clouding materials are added as required. (*Chem. and Ind.*, **34**, 493 (1915).)

Musiol, C.

PRODUCTION OF ENAMEL FOR APPLYING IN THE MOIST STATE. German Pat. 366,200, June 11, 1921; Addition to German Pat. 360,156.—The enamel contains barium oxide in addition to the constituents specified in the chief patent. On account of the poisonous nature of the barium, it is not suitable for enameling articles likely to come in contact with foodstuffs. (*Chem. and Ind.*, **42A**, 500 (1923).)

Musiol, C.

ENAMELS. British Pat. 142,688, June 6, 1919. (See U. S. Pat. 1,332,058, Feb. 24, 1920, given below.)—An enamel for sheet or cast irons is formed of a triple silicate of Al, Na, and Ca mixed with fluorides and coloring substances. (*Chem. Abs.*, **14**, 2846 (1920).)

Musiol, C.

ENAMEL FOR ENAMELING ARTICLES OF SHEET OR CAST METAL. U. S. Pat. 1,332,058, Feb. 24, 1920.—This is an enamel free of boron, lead, or arsenic compounds. The batch is made of saltpeter, soda, quartz, feldspar, kaolin, fluorspar, sodium silico-fluoride, cryolite, chiolite, antimony oxide, leuconine, magnesia, clay, tin oxide, and appropriate coloring oxides, all in varying proportions. (*Jour. Amer. Ceram. Soc.* (Abs.), **3**, 513 (1920); *Chem. Abs.*, **14**, 1204 (1920); *Chem. and Ind.*, **39A**, 297 (1920).)

Musiol, C.

EXACT NOTIONS OF FLUORINE ENAMELS. *Jour. Amer. Ceram. Soc.*, **7**, **105** (1924); *Bull. Amer. Ceram. Soc.*, **3**, 224 (1924).—The theories of Vogt, Grünwald, Mayer and Havas, and others regarding the rôle of fluorine in enamels are proved by mathematical means rather than chemical means to be incorrect. Fluorine is not volatilized as SiF_4, but disappears during the smelting process as F_2, although in the presence of B_2O_3 it may

be volatilized as BF_3. Enamel formulas should be studied by means of the "subtractive" analysis method. Discussion by J. E. Hansen, *Jour. Amer. Ceram. Soc.*, **7**, 115 (1924); and H. H. Stephenson, *Bull. Amer. Ceram. Soc.*, **3**, 226 (1924). (*Chem. Abs.*, **18**, 1041 (1924); *Chem. and Ind.*, **43B**, 382 (1924).) See *Bull. Amer. Ceram. Soc.*, p. 41, and Hansen, J. E., p. 145, this *Bibliography*.

***Musiol, C.**

FLUORINE ENAMELS. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 41).

Myers, W. M.

MINING AND PREPARATION OF FELDSPAR AND FLINT. *Ceramist*, **6**, 438 (1925).—Operations by which feldspar and flint are mined and prepared for the manufacture of ceramic products are described.

Nagasawa, Takeo

ENAMELING FURNACE. Japanese Pat. 39,806, Sept. 8, 1921.—A muffle furnace, in which materials are revolved during heating, is specified. (*Ceram. Abs.*, **2**, 65 (1923); *Chem. Abs.*, **16**, 3373 (1922).)

Nagel, Oskar

AMERICAN ENAMELING OVENS. *Chem. Ztg.*, **38**, 801 (1914).—Cuts of a tank oven, muffle ovens with and without regenerator, and a twin muffle oven with regenerator. (*Chem. Abs.*, **8**, 3105 (1914).)

Nailler, Raymond F.

ART OF ENAMELING OR THE COATING OF IRON AND STEEL WITH GLASS. *Mech. Eng.*, **35**, 1479 (1913); *Sci. Am. S.*, **76**, 338; *Met. Chem. Eng.*, **11**, 695; *Iron Trade Rev.*, **53**, 678 (1913); *Iron Age*, **92**, 843 (1914); *Foundry*, **42**, 7 (1914); *Eng. Mag.*, **46**, 603.—The fundamentals of sheet-steel and cast-iron enamels and the methods used for applying them are described. The selection of steel with a view to its chemical analysis is of prime importance. A typical reliable specification reads: S below 0.040, P below 0.30, Mn about 0.40, Si about 0.010, C about 0.10. To illustrate the chemical changes taking place in various stages of production of the enamel, N. gives the following formula of a typical cover coat used in the production of a "dark blue" cooking ware enamel: feldspar 120, quartz 72, borax 80, cryolite 30, saltpeter 7, CoO $7\frac{1}{2}$, MnO_2 1 part by weight, and clay in the mill 4%. By calculation it is shown that the theoretical loss of this batch on smelting is 8.2%. Color of ground coat is of small importance; it must be adherent and strong. In addition to the ordinary components CoO seems to be essential to the production of adherence. The cover coat is essentially a high silicate and must be free from any metallic oxides such as oxide of Sn, Pb, Fe, etc. Production of a good white enamel either for casting or sheet-steel work depends upon the use of SnO_2. Antimony does not produce as good a white as does tin. Certain compounds of Mn, Fe, Cu, and Ni give color approaching black. Manganese alone produces purples and violets. Green enamels are chiefly produced by use of Cr_2O_3 plus CuO and in some cases a mixture of CuO plus CoO. Reds are produced by use of Fe_2O_3 in connection with SnO_2. More delicate colors (rose and purple) found on jewelry are produced by the use of gold compounds. The best known gold compound is purple of Cassius, whose exact composition is a question. It is made by the combined use of auric, stannous, and stannic chlorides. (*Chem. Abs.*, **8**, 805 (1914).)

Nathusius, Hans

AMERICAN ELECTRIC ENAMELING FURNACE. *Centr. der Hütten und Walzwerke*, **30**, 310 (1926).—A description of the Hogan electric enameling furnace is given. Its

advantages are uniform heat, best heat transfer from the heating elements, highest thermal efficiency through uniform heat distribution, and the best heat insulation; heating is clean and the firing chamber is free from combustion gases, smoke, and dust; the temperature can be set accurately and is automatically regulated; production is 50% higher than in a coal-fired furnace as determined by square feet of surface enameled; complete elimination of waste or the need for repeated firing on account of faulty firing; the enameler can utilize 100% of the hearth surface; exact reproduction of colors and increased value of the final product; elimination of expense for firemen; transportation and storage of fuel and ashes; reduction of the maintenance and repair costs to a negligible amount; and better utilization of the skill of the service men. (*Ceram. Abs.*, **6**, 428 (1927).)

Nat. Glass Budget, **42**, 24 (1926).

WHY GLASS, ENAMELS, CLAYS ARE GROUPED IN CERAMICS.—By definition, ceramics is the science, technology, and art of manufacturing ware of silicates. Because glass, enamels, and clays are silicates of alumina and other oxides, they are grouped in ceramics. Reference is made to physical properties of material used in the ceramic trade and how they differ in their various manufacturing processes. (*Ceram. Abs.*, **5**, 333 (1926); *Bull. Amer. Ceram. Soc.*, **5**, 301 (1926).)

Neal, S. M.

MODERN METAL CLEANING. *Enamelist*, **2** [1], 10 (1924).—Foreign material to be removed (1) oxides, (2) grit, and (3) oil and grease. Methods: (1) firing-off process (450° F for 15 to 20 min.), (2) organic solvents: kerosene, gasoline, or benzol, (3) alkaline metal cleaners; alkaline salts of sodium and potassium, (*a*) still tank, (*b*) electro cleaning tanks, (*c*) continuous system. Factors involved in use of alkaline cleaners: (1) should instantly soften the water, (2) slight solvent action over some oxides, (3) will saponify animal or vegetable oil, (4) soap formed will absorb dust and grit, and (5) emulsification. Disadvantages of firing-off process: (1) oxidizes the metal, (2) tendency to warp sheet metal parts, (3) will not remove grit and sand, (4) fails to remove carbon produced from oil, (5) more costly than cleaning solution, (6) unpleasant for workman, and (7) does not clean successfully.

Neilson

IMPROVEMENTS IN ENAMELING METAL ARTICLES, AND IN THE MEANS AND APPARATUS OR MECHANISM THEREFOR. Specification 2483 (1871). (*Rep. der Tech. Lit.*, p. 405 (1869–1873).)

Nesbitt, C. B.

ABUNDANCE OF OILS OF GREATEST ADVANTAGE. *Ceram. Ind.*, **8**, 454 (1927).—A light oil is preferred because it is easier to handle and firing difficulties are not as numerous as with a heavy oil.

Nicholas, F. B., and Crane, A. T.

PRODUCING ORNAMENTAL ENAMEL DESIGNS. U. S. Pat. 477,568, June 21, 1892.—The method of producing designs in enamel colors, which consists in the application of soluble glass to the portions of the surface to be enameled, whereby the soluble glass serves first as a binder to hold the vitrifiable materials upon the surface prior to fusing, and afterward serves as a flux in the vitrified enamel.

Niedringhaus

MANUFACTURE OF ENAMELED IRONWARE. German Pat. 1270 (1877). (*Rep. der Tech. Lit.*, p. 76 (1877).)

Niedringhaus

ENAMELING ROLLED IRONWARE. *Maschinenb.*, p. 360 (1878); *Dt. Ind. Z.*, p. 256 (1878); *Z. f. Blechind.*, p. 283 (1878). (*Rep. der Tech. Lit.*, p. 97 (1878).)

Niedringhaus, A.

ENAMELED METALLIC WARE. British Pat. 16,107, July 21, 1896.—Heretofore iron has generally been used in preference to steel for the base of enameled metallic ware, on account of the pinholes, flecks, and chips, which generally appear if steel is employed, although steel has been used occasionally with a double coating of enamel. In the present invention, the pinholes and other imperfections are got rid of by placing sulphur with or without a chloride in the annealing pot, either before or after the shaping of the ware. The porportions required are about two pounds of sulphur to 100 pounds of steel, and the time of exposure to the sulphur vapors is from three to six hours. (*Chem. and Ind.*, **15**, 808 (1896).)

Niedringhaus, A.

MANUFACTURE OF ENAMELED WARE. U. S. Pat. 564,217, July 21, 1896.—The process of preparing steel for enameling, which consists in annealing it in the presence of a chloride and sulphur.

Niedringhaus, A.

MANUFACTURE OF ENAMELED WARE. U. S. Pat. 568,366, Sept. 29, 1896; British Pat. 21,512, Sept. 29, 1896.—The process of preparing steel for enameling, which consists in placing the steel, a chloride, and saltpeter in the annealing pot and subjecting the same to an ordinary annealing heat. (*Chem. and Ind.*, **16**, 44 (1897).)

Niedringhaus, F. G.

ENAMELING STEEL. U. S. Pat. 607,624, July 19, 1898.—The process of enameling on steel, consisting in stretching sheet steel, shaping the stretched sheet of steel in the form the finished article is to assume, coating such formed articles with enamel, and baking the coated article.

Niedringhaus, F. G., and W. F.

ENAMELING SHEET-IRON WARE. U. S. Pat. 199,735, Jan. 29, 1878.—The combination, with the ordinary glaze used in making mottled enameled sheet-iron ware, of sulphuric acid or equivalent liquid acid, to provide sufficient acid for the perfect oxidation of the base during the enameling process.

Niedringhaus, F. G., and W. F.

ENAMELING SHEET-IRON WARE. U. S. Pat. 200,626, Feb. 26, 1878.—Process consists in expelling the carbon from the metallic base before the formation of the enamel thereon by heating the articles in the presence of lime. The carbon, however, can be expelled from the iron when the latter is in the form of bars, and before it has been rolled into sheet iron.

Niedringhaus, W. F.

ENAMELING SHEET-IRON WARE. U. S. Pat. 193,669, July 31, 1877.—As soon as the ware, after withdrawing it from the baking oven can be handled, by suitable appliances, without injury to the enamel, and while the ware is yet in a highly-heated state, it is placed where the surrounding air is of the same temperature with the ware. It is then

cooled down very slowly, the operation lasting from four to six hours. In practice an ordinary glass annealing furnace may be used.

Niedringhaus, W. F.

MANUFACTURE OF ENAMELED WARE. U. S. Pat. 607,625, July 19, 1898.—The process of preparing a base for receiving a coat of enamel, which consists in immersing the base in a bath composed of two parts of water and one part of chloride of calcium, sprinkling sulphur on the base after it has been so immersed, and then annealing the base.

Niedringhaus, W. F., and G. W.

ENAMELING STEEL OR HOMOGENEOUS IRON. U. S. Pat. 632,737, Sept. 12, 1899.—In the process of enameling steel or homogeneous iron, the subprocess of enamelizing the metal which consists in bringing the steel or homogeneous iron into a molten state and introducing into the molten steel or homogeneous iron a mixture of the enamel fluxes, thereby adapting it to retain enamel having such or analogous fluxes.

Noack, Edward Henry

HEAT-RESISTING STEEL. U. S. Pat. 1,562,782, Nov. 24, 1925.—A steel containing silicon between 1.50 and 2.00%; copper between 0.50 and 1.00%; manganese not over 0.12%; and carbon not over 0.10%. (*Ceram. Abs.*, **5**, 46 (1926).)

Noel, C.

ENAMELING METAL ARTICLES, ETC. French Pat. 609,844, May 5, 1924.—The articles are treated with a current of air while the portion to be enameled is raised gradually to a suitable temperature. (*Ceram. Abs.*, **6**, 266 (1927); *Chem. and Ind.*, **46B**, 253 (1927).)

***Northwestern Terra Cotta Co.**

FURNACE DESIGN EXPERTS BUILD SMELTER FOR ENAMELS OR FRITS. See *Ceram. Ind.* (this *Bibliography*, p. 51).

Oberhoffer, P.

OXYGEN IN IRON. *Stahl u. Eisen*, **45**, 1341 (1925).—Nine synthetic irons and fourteen steels were examined for oxygen by the hydrogen, heat extraction, and bromine processes. The last two methods enable the changes in form of the oxygen compounds, after various metallurgical treatments, to be shown. A greater oxygen content was found in acid than in basic open-hearth steel. High oxygen content was associated with flaky fracture of saw steel and red shortness of a Ni-Cr steel. Photomicrographs are given showing the effect of oxygen in balling up the cementite network of iron, the coarsening of structure of annealed, eutectic steel, and the formation of troostite spots on quenching. A steel low in oxygen showed a higher impact resistance, but a greater temper brittleness than steel high in oxygen. (*Ceram. Abs.*, **5**, 13 (1926); *Chem. and Ind.*, **44B**, 763 (1925).)

Oberhoffer, P., and Wimmer, A.

EFFECT OF TEMPERATURE AND CHEMICAL COMPOSITION ON VISCOSITY OF IRON. *Stahl u. Eisen*, **45**, 969 (1925).—Viscosity was measured by the logarithmic decrement of a pendulum swinging in the molten iron. A sudden increase in viscosity is observed in pure iron-carbon alloys at 1335° for 2.62% carbon, and 1180° for 3.43% carbon; this

corresponds with the separation of mixed crystals. Phosphorus increases viscosity but lowers the initial solidifying point, which accounts for the apparently increased fluidity in practice. Manganous sulphide increases viscosity considerably, and carbon and silicon also increase it. (*Ceram. Abs.*, **5**, 12 (1926); *Chem. and Ind.*, **44B**, 634 (1925).)

O'Donnell, W. F.

SENDING THE GAS RANGE TO A FINISHING SCHOOL. *Enamelist*, **4** [9], 7 (1927).—The distinction that the present day kitchen has acquired is due to the introduction of enameled kitchen appliances, and particularly of the gas range.

Oesterle, G., and Markert, F. S.

FUNCTION OF MANGANESE DIOXIDE IN GROUND-COAT ENAMELS. *Bull. Amer. Ceram. Soc.*, **4**, 413 (1925).—Manganese dioxide is generally used in the ground-coat enamel in the amount of from 1 to 3%, to the raw batch weight. It acts chiefly as a coloring agent and is economical to use in replacing the cobalt and nickel oxides, which are much more expensive. Dependent upon the amount used, manganese dioxide varies in color from a drab green to a violet color. Also the use of borax and bone ash with it has influence over the color of the ground-coat enamel. In order to obtain a uniform and dark-colored ground coat, cobalt, or nickel oxide should be added. Manganese dioxide affects the physical porperties of the enamels as follows: It gives good gloss to the enamel. Harder enamel is obtained with less danger of overfiring. It reduces the coefficient of expansion of the glass it is used with. Adhesion of the ground coat to the steel is the same as when cobalt is used. It has no apparent effect on chipping of the enamel.

O'Hara, E.

RADIUM LUMINOUS COATINGS. U. S. Pat. 1,364,950, Jan. 11, 1921.—Watch or clock dials or similar articles are enameled, luminous markings are applied over the enamel and the markings are covered with a protective coating free from Pb and vitrified on the luminous surface. U. S. Pat. 1,364,951.—Relates to a similar method of preparing luminous dials in which the luminous material, *e.g.*, Zn sulphide Ra Br_2, is mixed with a reflux or glaze which is fired or vitrified on the surface after application as a coating or marking. The glaze may be a potash lime glass. (*Jour. Amer. Ceram. Soc.* (Abs.), **4**, 517 (1921).)

O'Hara, E.

APPARATUS FOR ENAMELING ARTICLES OF METAL, ETC. U. S. Pat. 1,535,850, April 28, 1925.—Apparatus for enameling articles having a conveyer for supporting the articles while receiving the coating of enamel, a second conveyer onto which the coated articles are transferred automatically from the first conveyer and a furnace through which the articles are carried by the second conveyer, each conveyer having a plurality of parallel runs, the adjacent ends of the runs of the two conveyers lapping past each other for some distance in such manner that the lapping portions of each run of each conveyer will be intermediate to runs of the other conveyer. (*Ceram. Abs.*, **4**, 184 (1925); *Chem. Abs.*, **19**, 1935 (1925).)

Olmstead, C. F.

THEORY OF COMBUSTION. *Enamelist*, **2** [8], 23 (1925).—Heat is a form of energy, not a material substance. It may be formed by friction, impact, resistance to the flow of electrical current, and by chemical reaction. Incomplete combustion may be repre-

sented by the reaction $2C + O_2 = 2CO$ and complete combustion as $2CO + O_2 = 2CO_2$.

AIR REQUIRED FOR AVERAGE OIL

	Analysis of an average fuel oil, per cent	Wt. in 1 lb.	Oxygen /lb. comb.	Net oxygen req.	Wt. air/lb.	Lbs. air required	Sp. vol. at 62°F	Cu. ft. air required
Carbon	85	= 0.850	× 2.66	= 2.261	× 4.35	= 9.835	× 13.14	= 129.23
Hydrogen	13.5	= 0.135	× 8.00	= 1.080	× 4.35	= 4.69	× 13.14	= 61.63
Oxygen	1.0	= 0.010	(neglect correction)					
Sulphur	0.5	= 0.005	× 1.00	= 0.005	× 4.35	= 0.022	× 13.14	= 0.29
Totals	100	1 lb.				14.547		191.15
Excess air to be supplied (30%)								57.35
Supply for combustion of 1 lb. of fuel								248.50

Olsberger and Altenbekener Eisenhüttenwerke

ENAMELED COOKING UTENSILS. German Pat. 244,389, March 2, 1911.—Detailed process of manufacturing enameled cooking utensils. (*Chem. Abs.*, **6**, 2304 (1912).)

Onan, R. M.

STUDY OF FUEL PROBLEM. *Ceram. Ind.*, **4**, 110 (1925).—The relative advantages and disadvantages of coal, oil, gas, and electricity as fuels in the enameling industry are discussed. (*Ceram. Abs.*, **4**, 126 (1925).)

Onan, Robert

OIL CHEAPEST FOR ENAMELERS. *Ceram. Ind.*, **8**, 452 (1927).—The advantages for oil are reviewed.

***O'Neil, R. D.**

OPAQUING COMPOSITION FOR ENAMELING MIXTURES. See Perino, J. (this *Bibliography*, p. 233).

Opderbeck, Emil

GRANULATING LIQUID SLAG. U. S. Pat. 1,483,241, Feb. 12, 1924.—Method for granulating liquid slag, consisting in feeding the liquid slag onto a centrifugally operating expelling element capable of impelling the slag against an abutment, and in supplying water onto the element in quantities limited by the amount which the heat supplied by the slag is capable of converting into steam, to cause the granulation of the slag into dry slag sand. (*Ceram. Abs.*, **3**, 122 (1924).)

Orth, F. A.

GROWTH IN SIGN BUSINESS DUE TO PORCELAIN ENAMEL. *Enamelist*, **5** [1], 61 (1927).—The durability of enameled signs has caused a tremendous growth of this business. The enameling process and the various types of signs manufactured by the Federal Electric Co., Chicago, Ill., are described in this article.

Orton, E., Jr.

PLASTICITY OF CLAY. *Brick*, **14**, 216.

Orton, Edward, Jr.

TESTING OF ENAMELED SHEET-STEEL WARE. *Trans. Amer. Ceram. Soc.*, **11**, 320 (1909).—I. An account of tests made on auto tags for State of Ohio, 1908. The following tests were made: (1) appearance, workmanship, and luster, (2) solubility of enamels in water, (3) solubility of enamels in dilute acid, (4) ability of enamels to resist acid gases or vapors, (5) ability to withstand flexure or bending without cracking,

and (6) ability to withstand impacts without shattering. II. Outline of tests: (1) Tests are purely matters of opinion or judgment. None of them admit of measurement. (2) Pieces boiled in pure distilled water continuously for 8 hours; loss in weight then noted; 0.05% maximum solubility allowed in these specifications. (3) One per cent sulphuric acid heated to boiling: pieces immersed and kept there for 15 minutes. Bare iron was coated with shellac before the piece was placed in the acid. Loss in weight noted. Maximum loss allowed 1.5%. (4) Pieces exposed for 18 hours in a bell jar in which a beaker of strong hydrochloric acid was sitting. No heat was used. Tags were then washed, dried, and the loss in weight noted. Maximum loss allowed in these standards was 0.5%. (5) Pressure applied so that the measured deflection increased at increments of 0.01 inch. After each deflection load was applied, the piece was removed and examined under the glass for cracks. (6) Page impact machine: hammer weighing one kilogram falling from 1 to 9 cm. was used. Effect noted after 10, 20, 40, 75, and 100 blows. (Height of hammer used was not noted.) Boehme hammer test. Blows of four different degrees severity were used and the results noted. These tests were used on auto tags submitted by different companies. Discussion by Mr. Chormann, Mr. Barringer, and Mr. Frink. (*Chem. Abs.*, **3**, 2741 (1909); *Chem. and Ind.*, **28**, 1130 (1909).)

Oschatz, H.

ENAMELING METAL OBJECTS. British Pat. 11,991, May 26, 1902.—A process of protecting the outside of nickel sheet-iron articles, during the process of enameling them internally, by the application either of a thick nickel plating or of an electrolytic deposit formed on the article which is removed after the enameling operation. (*Chem. and Ind.*, **21** 1139 (1902).)

Ostwald, W.

VELOCITY FUNCTION OF VISCOSITY OF DISPERSE SYSTEMS. *Koll. Zeit.*, **36**, 99, 157, 249 (1925).—(*A*) The deviations of the measurements with a viscometer of many colloid solutions from the requirements of the Hagen-Poiseuille law cannot be attributed to one mechanical variable, *e.g.*, elasticity, for M. Planck has shown that the deformability of an ideal elastic body depends on 36 parameters and it is probable that the mechanical properties of structural colloids are still more complicated. It is suggested that all these deviations be included in the one conception, "structural viscosity." Since the evidence of structural viscosity would be variation of pressure or of the velocity of flow, it can be measured by means of an ordinary or slightly modified capillary viscometer. It would only be necessary to vary the height when filled (*e.g.*, lengthen the shank) or to attach a manostat to the viscometer. A very simple pressure viscometer (modification of the Ostwald type) has been devised, by means of which the measurement of the velocity function or structural viscosity is as easy as the usual measurements with the capillary viscometer. The equations which have been developed to show the dependence of v or η upon p with different liquids and experimental conditions include: (1) $v = kp$, $\eta = kpt$, the Hagen-Poiseuille law especially applicable to small tubes, long capillaries, and small velocity of flow; (2) $v^2 = kp$, $\eta = kp^{1/2}t$ developed by Darcy for wide tubes and moderate velocity of flow; (3) two equations by Osborne-Reynolds, the first, $v^{1.76} = kp$, $\eta = kp^{1/1.76}\,t$ for wide tubes and high velocity of flow (for water) and the second, $v^x = kp$, $\eta = kp^{1/x}t$, where x varies between 0.5 and 1.0, for almost any experimental conditions but with very rapid changes in the values for the exponents at certain critical velocities; (4) $v^{1/n} = kp$, $\eta = kp^nt$ by Ostwald for widely different liquids, particularly colloid dispersions with small velocity of flow, and widely varied experimental conditions and apparatus. O. has also shown that instead of $pt = k$, the equation $p^nt = k_2$ or $t_k = k_2t_w^n$, where n is 1.0 to 2.0, holds throughout a very wide

range. In these equations, p is the pressure, t_k and t_w are the velocities of flow, respectively, of the colloid and water, and n and k_2 are constants. In many cases, still better results have been obtained by the equations in the form, $t_k = t_w + k_2 t_w^n$ and $t_k = k_s\,(t_k - t_w)^n$. The corresponding equations for measurements with the Hess apparatus are, when t is constant, $p^n/V_k = k_5$ and $(V_w/V_k)p^n = k_6$; with the Couette apparatus $A_k D^{1/n} = k_7$. V_w and V_k are the volumes, respectively, of the colloid and the water, A_k is the deflection in degrees through the colloid and D the reciprocal of the velocity of rotation. The validity of these relations for measurements with a capillary viscometer is shown in 20 tables for about 25 different solutions. Measurements were made with seven types of apparatus by about eight experimenters. The solutions measured included: V_2O_5, benzopurpurin, cotton yellow, sodium stearate, mercury sulphosalicylate, agar, tragacanth, gum arabic, gelatin of different concentrations and heat treatment, viscose, india-rubber in toluene, xylene, and benzene. The average difference between the measurements and the calculated values seldom exceeded 2% and with the more carefully measured values was less than 1%. (*B*) The general equations previously developed for the velocity function of structural colloids have been shown to be valid not only for the capillary viscometer but also for measurements with the Hess apparatus and the Couette apparatus. When compared with measurements made by Hess, Rothlin, Freundlich, and Schalek with the Hess apparatus for solutions of V_2O_5, benzopurpurin, gelatin, egg white, agar, starch, and soap, the velocity function could be calculated within 1 to 2% error. When the pressures were less than 1 cm. of mercury, the error was very large. When compared with measurements made by Hatschek, Freundlich, and Schalek with the Couette apparatus for cotton yellow and gelatin the error was 1.7 to 2.4%. The values for n as determined for all different conditions were between one and two. (*C*) The simple logarithmic relation between viscosity and the velocity of deformation has been used for the special cases of vaseline and starch paste by de Waele and by Farrow and Lowe. Ostwald has drawn the following conclusions from the work described in this series of articles: (1) This logarithmic function is valid for about 25 different kinds of solutions in capillary viscometers of very different kinds. (2) The same relation holds for measurements with the Hess and the Couette types of apparatus, having a very general application. (3) The relation of this function to the Hagen-Poiseuille law and to the symmetrically adjoining field of anomalous viscosity (at higher pressures) has been developed and thereby the importance of the logarithmic equation extended. The behavior in both fields of anomalous viscosity may be represented by the same logarithmic equation with this algebraic distinction, that with the higher pressures the exponent of the pressure is made less than one and with the lower pressures greater than one. (*Chem. Abs.*, **19**, 2288 (1925).)

Ostwald, W., and Rath, W.

SURFACE TENSION OF CLAY SLIP. *Kolloid-Z.*, **36**, 243 (1925).—In some respects doughs and magmas such as clay slip are like solids, in others they are like liquids. Clay slip will pass through small tubes and form drops at the end of a tube as liquids do. The apparatus used to determine surface tension was a stalagmometer with tubes 0.5 cm. in diameter. The tip from which the drops fell was enlarged on the outside and the bore almost closed at the tip. By means of a 3-way stop-cock at the upper end of the tube, suction for drawing the slip into the tube, or pressure for causing it to flow out uniformly could be applied and regulated. The equations used were $o = k_1 g$ (1), $g = dv$ (2), $v = k_2 Z^{-1}$ (3), where o = surface tension, d = the density, v = the volume of a drop and Z = the number of drops in the volume of the stalagmometer: and $d = k_3 c$ (4), if it is assumed that density is proportional to concentration c. From these $o = k_4 d Z^{-1}$ (5), or $o = k_5 c Z^{-1}$. The rate of formation of drops was not given, and no correction

was made for the shape of the drop. For three kinds of clay the drop numbers for all concentrations decreased when subjected to mechanical treatment. As the concentration of any clay is increased the drop number increases to a maximum, when the concentration is between 15 and 20% and then decreases. These phenomena are explained by assuming a structure in the water-clay mixture. Deformation of this structure in the inner part of a body is opposed by viscosity; surface deformations are opposed by surface tension. Each increase in surface disturbs the optimum arrangement of particles. (*Ceram. Abs.*, **4**, 292 (1925).)

Otremba, A.

MELTING POINT OF ENAMELS. *Keram. Rundschau*, **33**, 201 (1925); *Jour. Soc. Glass Tech.*, **9**, 96 (1925).—An account of the relative effects of fluorspar, cryolite, and sodium fluosilicate on the melting point of an enamel composed of quartz 19.1, B_2O_3 4.32, borax 34.4, feldspar 34.6, Al_2O_3 3.19, and fluorspar 3.5%. The fluorspar was increased progressively to 72% at the expense of the other ingredients. Also the quartz and feldspar contents were varied over a wide range. O. concludes that fluorspar acts sometimes as a flux, again as a refractory material. Similar experiments were carried out with cryolite and sodium fluosilicate. No mention is made as to what method was used for determining the melting point. (*Chem. Abs.*, **20**, 3789 (1926).)

Otremba, A.

VOLATILIZATION OF SODIUM FLUOSILICATE. *Keram. Rundschau*, **33**, 343, 364 (1925); *Jour. Soc. Glass Tech.*, **10** [40], 235 (1926).—The experiments were made in a small furnace and the temperatures measured by Seger cones and pyrometers. The carbonates employed were effective in reducing volatilization of fluorine, but calcium carbonate could not act until it commenced to dissociate. Quartz, feldspar, and clay when used singly, gave similar results. Dissociation was not complete in any case at 1000°. Tests with borax and boric acid were abnormal because of the possibility of decomposition of some sodium fluoride from the sodium fluosilicate, and its volatilization as fluoborate. (*Ceram. Abs.*, **6**, 275 (1927); *Chem. Abs.*, **21**, 2967 (1927).)

Otremba, A.

MICROSCOPIC INVESTIGATION OF OPACITY PHENOMENA IN ENAMEL FRITS. *Keram. Rundschau*, **34**, 67 (1926).—It was found that in order to opacify enamel frits with fluorspar it is important to have alkalis and Al_2O_3 present. They probably produce Al and alkali fluorides in the frit. That alkalis are important in the production of opacity was shown when borax was substituted for KNO_3 which resulted in frits having poorer opacity. Increasing the fluorspar content in frits increases the refractoriness. Natural cryolite is superior to fluorspar for opacifying frits. For example, it is not necessary to introduce alkalis and Al_2O_3 along with the frit in order to obtain opacity with cryolite because they are already in this mineral. With fluorspar, opacity is first obtained by heating the frit to 950°C whereas with cryolite this is obtained at 750°C. Artificial is better than natural cryolite for opacifying enamels. (*Ceram. Abs.*, **6**, 265 (1927); *Chem. Abs.*, **21**, 2065 (1927).)

Otremba, A.

OPACITY PHENOMENA. *Keram. Rundschau*, **34**, 67, 88, 107 (1926).—Opacifying effects of fluorine compounds, without tin oxide were studied under the microscope. The frits were allowed to cool in air not quenched in water as is the usual practice. The compounds tested were fluorspar, natural and artificial cryolite, and sodium silicofluoride. Silico-fluoride was the best opacifier at low temperatures, provided that enough feldspar is present to supply alumina and alkalis. Artificial cryolite is more

opacifying than natural cryolite, which in turn is better than fluorspar at low temperatures. Fluorspar requires high temperatures to produce opacity, or alternatively, high per cent of fluxes. When present in large proportion, fluorspar raises the melting point of the frit. (*Ceram. Abs.*, **5**, 299 (1926); *Chem. and Ind.*, **45B**, 542 (1926).)

Otremba, A.

FLUORINE IN ENAMEL MELTING. *Keram. Rundschau*, **34**, 158 (1926).—O. used the formulas developed by Vielhaber. Increasing cryolite in enamels causes increased solution of feldspar and quartz. Artificial cryolite produces better opacity than the natural. The opacity is due to crystals when cryolite is used and to fine air holes when fluorspar is employed. (*Ceram. Abs.*, **5**, 299 (1926); *Chem. Abs.*, **20**, 3339 (1926).)

Otremba, A.

LOSS OF WEIGHT OF CRYOLITE. *Keram. Rundschau*, **34**, 411 (1926).—O. found that sodium fluosilicate has a greater loss of weight upon heating than cryolite and this takes place at comparatively low temperatures. With cryolite it appears that sodium influences the volatility most. It does not appear that SiF_4 is as volatile as sodium compounds as was thought to be the case. (*Ceram. Abs.*, **5**, 329 (1926).)

Otremba, A.

VOLATILIZATION OF CRYOLITE. *Keram. Rundschau*, **34**, 375, 397, 411, 432 (1926).—Cryolite acts as a strong opacifier in enamels because the fluorine combines with certain constituents of the enamel to form a crystal compound. When heated to a higher temperature this compound decomposes, giving off fluorine gas. Cryolite also acts as a flux in certain cases whereas in others it acts as a refractory. If the cryolite content is increased in enamels containing quartz and feldspar contents of about 50% the melting point is decreased until 20% cryolite has been added. (*Ceram. Abs.*, **6**, 471 (1927); *Chem. Abs.*, **21**, 2967 (1927).)

Otremba, A.

INFLUENCE OF ELECTROLYTES ON ENAMELS. *Keram. Rundschau*, **34**, 506 (1926).—When enamel slips are taken from a mill they are usually too fluid and must be thickened by adding suitable electrolytes. Magnesium sulphate increases the viscosity most effectively, but the sulphate radical may cause a dulling of the enamel. Ammonium chloride is almost as effective as magnesium sulphate; since it is practically all volatilized it does not affect the enamel. Too much borax is required to thicken the enamel, about 5% being necessary. Large amounts of sodium carbonate, sodium sulphate, and sodium chloride also are required to thicken enamel slips and their use is not promising. Chlorides have a dulling effect on enamels similar to sulphates. A mixture of ammonium chloride and magnesium sulphate is especially detrimental. (*Ceram. Abs.*, **5**, 343 (1926); *Chem. Abs.*, **20**, 3220 (1926).)

Otto, A. P.

METHOD OF AND APPARATUS FOR ENAMELING. U. S. Pat. 605,903, June 21, 1898.—An apparatus for enameling comprising a closed apartment, a receptable adjacent to the apartment for receiving the ingredients of the enamel, means for projecting the ingredients throughout the apartment, and movable shutters for decreasing the size of the apartment.

***Pacific Sanitary Mfg. Co.**

CALIFORNIA SANITARY ENAMELED WARE PLANT. See *Metal Work*, this *Bibliography*, p. 215.

Paige, D. O.

ENAMELING OVEN OR KILN. U. S. Pat. 457,821, Aug. 18, 1891.—Apparatus for heating or enameling metallic rings or cylinders, etc., consisting of an oven having a floor provided with an opening, a rotary support projecting into the oven through the opening, which forms an annular space around the support for the passage of heated air, furnaces connected by flues with the space beneath the oven floor, a chimney communicating with the space below the oven, means, substantially as described, for operating the rotary support from the exterior of the oven, and a well or passage through which the operating mechanism of the rotary support extends and by which it is accessible without cooling the oven.

Palmaer, W.

CORROSION OF METALS. *Korrosion u. Metallschutz*, **2**, 3, 33, 57 (1926).—Velocity of dissolution of metals is governed by difference in potential, by the conductivity of the solution, and by the resistance capacity of the local cells. To account for maximum and minimum in rate of solution, it is pointed out that the solution of the less noble metals results in a greater exposure of the more noble impurity. When an absolutely pure metal is not attacked, the whole of the surface has the same potential. The electric conductivity of the liquid film on iron appears to be the controlling factor in causing rust. (*Ceram. Abs.*, **5**, 300 (1926); *Chem. and Ind.*, **45B**, 589 (1926).)

***Panton, H. D.**

FREE QUARTZ IN FELDSPAR. (Discussion.) See *Ceramist* (this *Bibliography*, p. 62).

Parfitt, H. T.

IMPROVEMENTS IN KILNS OR OVENS FOR FIRING GLASS, ENAMELWARE, ETC. British Pat. 4592, March 24, 1890.—The kilns are heated by burners in which atmospheric gas or water-gas, etc., is used. The flame follows the curved roof of the kiln so that the products of combustion do not come into contact with the articles treated. Deflecting blocks are placed so that the flame does not pass directly to the flues. The products of combustion are employed to heat up a second chamber, usually placed above the first. The articles to be treated are placed on low trucks which run on rails and can be drawn out without interrupting the process. These trucks are provided with movable fire clay partitions, by means of which the size of the chambers can be reduced at will. When the truck is drawn out of the kiln a cover of iron wire quilted with asbestos is placed over it, forming an annealing chamber. (*Chem. and Ind.*, **10**, 465 (1891).)

Paris

PROCESS FOR PROVIDING SHEET IRON OR WROUGHT IRON WITH A GLASSY COATING. *B. d. s. d'enc.*, p. 75 (1850). *Dingl. p. J.*, **113**, 391. (*Rep. der Tech. Lit.*, p. 272 (1823–1853).)

Paris

ENAMELING OF CAST IRON. *Genie*, **36**, 74. (*Rep. der Tech. Lit.*, p. 306 (1854–1868).)

Paris

ENAMELED IRONWARE. (*Rep. der Tech. Lit.*, p. 306 (1854–1868).) *Pr. Mech. J. S.*, **4**, 284.

Paris

NEW PROCESS OF ENAMELING. *Pr. Mech. J. 2 S.*, **6**, 34. (*Rep. der Tech. Lit.*, p. 306 (1854–1868).)

Paris

NEW PROCESS OF ENAMELING. *Prop.*, p. 50 (1868). (*Rep. der Tech. Lit.*, p. 306 (1854–1868).)

Paris and Tulout

COMPOSITION OF ENAMEL AND THE COATING OF THE SAME ON METAL AND GLASS. *Br. d'inv.*, **16**, 310. (*Rep. der Tech. Lit.*, p. 272 (1823–1853).)

***Parmelee, C. W.**

MEASUREMENT OF PLASTICITY. See Talwalkar, T. W. (this *Bibliography*, p. 308).

Parsons, A. B.

RUBBER LINING FOR BALL MILLS. *Eng. Min. J.-Press*, **116**, 489 (1924).—Originating in observation of the remarkable wearing power of automobile tires over rocky roads, the idea of using similar rubber linings for ball mills has been developed and applied successfully at the Nipissing Mining Company's plant near Cobalt, Ont. The idea has been patented. The rubber is not hard but rather soft, tough, and well vulcanized. A 4- by 20-ft. mill, charged with 20 tons of 1.25-in. iron balls and used for regrinding sand from a Dorr classifier, was lined with a $^5/_8$-in. layer of rubber in January, 1923. After steady use it was still in first class condition in August, 1923. The cost of a $^5/_8$-in. rubber lining is slightly less than that of a 2-in. iron lining. Such a rubber lining is much easier to install or replace, has about $^1/_{20}$ the weight of the iron, and will last at least as long and probably much longer. The rubber lining also gives much increased grinding capacity and somewhat less ball consumption. (*Ceram. Abs.*, **3**, 51 (1924).)

Patch, William E.

REMOVING ENAMEL FROM ENAMELED METAL ARTICLES. U. S. Pat. 1,416,865, May 23, 1922.—The method of de-enameling enameled metal articles which consists in subjecting the article in a closed oven to a temperature above the original baking temperature. (*Ceram. Abs.*, **1**, 335 (1922); *Chem. and Ind.*, **41A**, 548 (1922).)

Pauls, C. F.

ENAMELING. U. S. Pat. 467,356, Jan. 19, 1892.—A composition of matter to be used in enameling, which composition is composed of calcined lead and tin, and porcelain, common salt, white arsenic, and one pound of glass and twenty pounds of white sand.

Pearson, B. M.

CERAMIC GLAZES AND ENAMELS. *Ceram. Age*, **10**, 92 (1927).—Formulas are given for various types of porcelain glazes. Some of the work on enamels containing zirconium is reviewed.

Perdonnet

PROCESS OF ENAMELING CAST-IRON POTS. *L'industr.*, **8**, 169. (*Rep. der Tech. Lit.*, p. 272 (1823–1853).)

Perino, J., O'Neil, R. D., and Gramm, F. G.

OPAQUING COMPOSITION FOR ENAMELING MIXTURES. U. S. Pat. 1,492,578, May 6, 1924.—Reactive silica and tin oxide containing sodium oxide or other alkali are used for opaquing enamels. A suitable mixture may analyze: SnO_2 83.5, H_2O 7.9, SiO_2 3.4,

Na_2O 3.7, and NaCl 1.0 part. (*Chem. Abs.*, **18**, 2064 (1924); *Chem. and Ind.*, **43B**, 675 (1924).)

Perkins, J. E.

CHANGES IN PLANT PRACTICE. *Enamelist*, **5** [1], 74 (1927).—Short review of some of the changes that have taken place in the industry and comments on the use of fuel oil.

Perrott, G. St. J., and Thiessen, G.

CARBON BLACK, PROPERTIES AND USES. *Ind. Eng. Chem.*, **12**, 324 (1920).—Description of the manufacture of carbon black. The use of carbon black in ink, rubber goods, paint, enamel, etc., is discussed, testing methods and specifications are presented, and the need for development work on more efficient methods of production and for a search for new sources of supply is emphasized. (*Chem. Abs.*, **14**, 1448 (1920).)

Petrik

ENAMELS FOR IRON AND OTHER METALS. *Monit. de la céramique et de la Verrerie*, **21**, 199 (1890).—In case the enamel leaves the iron or if the surface of the iron should become curved, that is to say, if the contraction of the enamel on cooling be less than that of the metal, then according to P. the following points must be attended to: Either (*a*) the percentage of silica must be increased, (*b*) part of the boric acid must be replaced by silica, (*c*) in the case of enamels containing lead a portion of the oxide of lead must be replaced by alkali or alkaline earth, (*d*) part of the alkaline earths must be replaced by alkali, (*e*) the quantity of alkali must be increased, and the boric acid decreased, (*f*) part of the oxide of tin may have bone ash substituted for it. The composition is given of a number of satisfactory enamels. (*Chem. and Ind.*, **10**, 138 (1891).)

Pfalzgraf, Charles F.

ENAMELING METAL. U. S. Pat. 774,491, Nov. 8, 1904.—An enameled article having a metal base provided with incisions extending partly through the metal and having the edges of the metal at the incisions projecting partly over the incisions, and a vitreous enamel coating the entire surface of the article and filling the incisions.

Pfefferhorn, K.

MEASURING PLASTICITY OF CLAY. *Brit. Clayworker*, **33**, 120 (1924).—A new method for measuring the plasticity of clay has been devised by P. which consists in dropping a weight on a clay cylinder $1^5/_{16}$ by $1^9/_{16}$ inches. The deformation of the clay cylinder is noted and the plasticity number determined. The per cent water in the clay cylinder which is compressed $^1/_3$ of its original length is called the plasticity number. The following table shows the plasticity numbers and mineral composition of 5 clays:

	Clay A	Clay B	Clay C	Zettlitz kaolin	Earthenware
Clay substance	70.2	90.6	87.9	94.2	53
Feldspar	3.7	2.0	3.4	1.8	12
Quartz	26.1	6.4	8.7	4.0	33
Plasticity number	26.6	34.0	28.0	33.5	23.2

(*Ceram. Abs.*, **3**, 326 (1924).)

Phillips, A. J.

PARTIAL PURIFICATION OF ZIRCONIUM OXIDE. *Jour. Amer. Ceram. Soc.*, **1**, 797 (1918).—Description of work done to remove ferric oxide from crude zirconia. Several methods were tried, but the use of chlorine was the most satisfactory. The chlorine was passed through a bubble tube near the furnace. Cold water was not nearly as efficient as hot water in the bubble tube in retarding the choking of the apparatus

with volatilized iron chloride and probably for larger installations the injection of low pressure steam along with the chlorine would be most satisfactory.

Pierce, H. C., and Humphries, C. H.

ENAMELING CADMIUM AND ZINC SURFACES. U. S. Pat. 1,583,006, May 4, 1926.—The surfaces are treated with a solution of an arsenate and enameled in the usual way. (*Ceram. Abs.*, **5**, 385 (1926); *Chem. and Ind.*, **45B**, 542 (1926).)

Piwowarsky, E.

INFLUENCE OF TEMPERATURE ON GRAPHITE FORMATION IN IRON. *Stahl u. Eisen*, **45**, 1455 (1925).—The heat of formation of iron carbide is first negative (1150 to 1500°), passes through (1500 to 1550°), and then becomes positive (1550 to 1560°). On iron becoming molten, both iron carbide and elementary carbon go into solution, but the carbon tends to change into the carbide molecular arrangement, two kinds of molecules in fluid iron being inferred, the carbide and carbon arrangements, respectively. To test the sluggishness of the molecular transformation, iron with 2.4% silicon was heated to 1600°, cooled to 1400°, and maintained at that temperature for different periods. The combined carbon was found to increase with time, but at 1200° hardly any effect was observed. (*Ceram. Abs.*, **5**, 45 (1926); *Chem. and Ind.*, **44B**, 805 (1925).)

Plauson, H.

REMARKABLE GRINDING MILL. *Brit. Clayworker*, **31**, 332 (1922).—A mill, which can grind materials so fine that they enter into the colloidal state and so remain in suspension for an indefinitely long period, has been invented by Dr. Plauson and is now obtainable in commercial sizes. This "colloid mill" resembles the ordinary disintegrator used for very wet materials but is driven at a much higher speed (3000–4000 r.p.m.). The material to be ground is mixed with 8 or 9 times its weight of water, and is then passed through the mill, which reduces the solid particles to less than $^1/_{30,000}$ inch in diameter, and as their surface tension is greater than the effect of gravity, they remain in suspension until precipitated by chemicals or other agents. This machine is capable of many uses and by its means clay of exceptional fineness can readily be prepared. The ground materials can only be separated from the water or other fluid in which they are suspended by passing the mixture through a special filter. (*Ceram. Abs.*, **2**, 77 (1923).)

Plausons Forschungsinstitut G.m.b.H.

PRODUCTION OF ENAMEL. German Pat. 388,902, May 14, 1922.—Enamels are produced by the wet grinding of molten and granulated enamels (with or without coloring agents and fillers) with the addition of a dispersing agent in a disintegrator running at least 1000 revs. per min., *e.g.*, in a colloid mill, so as to reduce a suitable proportion of the material to the colloidal state. If a metal or other substance which is insoluble in glass is included in the mixture, the resulting enamel produces an aventurine effect. Alternatively only the coloring and filling constituents may be ground in the colloidal mill, and then added to the ground or granulated glaze frit. In the case of mixtures which on firing do not form products having an injurious effect on the glaze, the usual melting or fritting operation may be dispensed with, the enamel mass being ground in the colloidal mill, and then applied directly to the object to be coated. (*Chem. and Ind.*, **43B**, 634 (1924).)

Pleischel

ENAMEL ON IRON. *Dingl.*, **147**, 237; *Ctrlbl.*, p. 491 (1858); *Bull. d'enc.*, p. 451 (1858). (*Rep. der Tech Lit.*, p. 306 (1854–1868).)

Pleischel

ENAMEL FOR VESSELS AND SHEET IRON. *Erfind*, **14**, 139. (*Rep. der Tech. Lit.*, p. 127 (1885–1887).)

Ployer, Albert E.

ENAMELWARE PROTECTOR. U. S. Pat. 1,447,180, Mar. 6, 1923.—The combination of a vessel enameled on the outside, and a protecting ring of copper arranged around the lower portion of the vessel, and having an annular integral portion extending inwardly under the bottom of the vessel. (*Ceram. Abs.*, **2**, 175 (1923).)

Polansky, Victor S.

PICKLING OF IRON AND STEEL: A BIBLIOGRAPHY. (*Blast Fur. Steel Plant*, **12**, 326 (1924); *Forging-Stamping and Heat Treatment*, **10**, 267 (1924).)—Complete bibliography on above subjects. References are grouped under the following subjects: (1) general and miscellaneous, (2) machines and equipment, (3) pickling in acid solutions, (4) pickling in salt solutions, (5) electrolytic pickling, (6) inhibitors and accelerators, (7) effect of pickling, and (8) recovery of spent liquors.

Pol. Notizbl., **40**, 125.

ENAMEL FOR METALS.—A mixture of 12 parts of borax, 20 parts of soda, and 125 parts of flint glass is fused, poured on a cold plate, pulverized, and the powder mixed with a solution of soluble glass of 50° Bé. The metal is coated with this paste, gently heated in an oven until the coating is fused, and is then allowed to cool. It adheres firmly to all kinds of iron articles. (*Chem. and Ind.*, **4**, 596 (1885).)

Polyt. Not. Bl., **44**, 82; *Hann. Gew. Bl.*, No. 6, p. 86; *Gew. Z.*, **54**, 201; *Ind. Z. Rig.*, **48**, 93; *Met. Arb.*, **15**, 132; *Uhland's W.*, **3**, 141; *Gew. Bl. Bayr.*, **21**, 106; *Eisen Z.*, **10**, 224.

ENAMELING OF CAST-IRON. (*Rep. der Tech. Lit.*, p. 118 (1888–1890).)

***Popp, G.**

USE OF OPACIFIERS CONTAINING ANTIMONY IN THE ENAMEL INDUSTRY. See Haupt, H. (this *Bibliography*, p. 149).

***Porcelain Enamel and Mfg. Co.**

AUTOMATIC EQUIPMENT LOWERS ENAMEL SMELTING COST. See *Ceram. Ind.* (this *Bibliography*, p. 54).

PICKLE-ROOM PRACTICE AT PEMCO. See Edgar A. Worsham (this *Bibliography*, p. 342).

Porst, C. E. G., and Moskowitz, M.

COMPARISON OF VARIOUS CORN PRODUCT STARCHES SHOWN BY BINGHAM-GREENE PLASTOMETER. *Ind. Eng. Chem.*, **14**, 49 (1922); *ibid.*, **15**, 166 (1923).—Ten samples of corn-starch were tested in a plastometer. The data obtained, when used with the chemical analysis, permitted the matching of products and often indicated the best one for a given use. The final temperature to which the pastes were heated affected the values obtained. (*Chem. Abs.*, **16**, 657 (1922).)

***Portevin, A.**

DILATOMETRIC ANALYSIS OF CAST IRON. See Chevenard, P. (this *Bibliography*, p. 66).

Poste, E. P.

REPORT OF THE ENAMEL DIVISION COMMITTEE ON STANDARDS, 1925–1926. *Bull. Amer. Ceram. Soc.*, **5**, 230 (1926).—The Committee undertook problems of the following general classification: (1) flotation of enamels; (2) opacity, color, reflecting power, and associated properties; (3) standardization of raw materials, and (4) standardization of control tests. Bibliographies of literature on plasticity and setting up of enamel slips, and enamel tests and methods of control are given. Partial results of a study of a representative group of clays in an effort to correlate enamel suspending power with chemical composition, mineralogical constitution, settling behavior with distilled water and with enamel, and the presence of organic matter are given. The methods of testing are explained. Ten control tests are listed and explained. Results of a questionnaire in regard to control tests are given and discussed. Eighteen replies were sent in to the questionnaire. Bibliography of literature on enamel tests and methods of control by Bryan A. Rice. Bibliography of literature on plasticity and setting-up of enamel slips by R. D. Cooke. (*Ceram. Abs.*, **5**, 203 (1926).)

Poste, E. P.

ENAMELING PLANT AT CHATTANOOGA, TENN. *Ceram. Age*, **9**, 44 (1927).—A description of the Chattanooga Stamping and Enameling Co., of the different stages of manufacture, and of the methods used in technical control. A diagram and photographs are given. (*Ceram. Abs.*, **6**, 169 (1927).)

Poste, E. P.

ENAMELING INDUSTRY IN THE SOUTH. *Ceramist*, **7**, 329 (1926).—The immediate past has witnessed a definite increase in the output of the southern enameling plants and expansions now under way point to a still greater production. P. describes the establishment and development of the enameling plants in Nashville and Chattanooga, Louisville, Ky., and Charleston, W. Va. The plant of the Standard Sanitary Mfg. Co. at Louisville is enormous in extent, employing 4500 men and producing 100 carloads of ware per week. The plants of the other important enameling companies of the South are also described. (*Ceram. Abs.*, **5**, 143 (1926); *Chem. Abs.*, **20**, 1894 (1926).)

Poste, E. P.

MANUFACTURE OF ENAMELED-LINED APPARATUS. *Chem. Met. Eng.*, **19**, 400.—Descriptive article of the general manufacturing operations. (*Chem. Abs.*, **12**, 2676 (1918).)

Poste, E. P.

ENAMELED-PRODUCTS RESEARCH LABORATORY. *Chem. Met. Eng.*, **25**, 974 (1921).—A detailed description of the research laboratory of the Elyria Enameled Products Co., Elyria, Ohio. Facilities are provided for small-scale factory operation experiments in ceramic engineering, with special reference to enameling of metals, chemical engineering, and metallurgical engineering. An analytical department serves the three other departments. (*Ceram. Abs.*, **1**, 85, 191 (1922); *Chem. Abs.*, **16**, 323 (1922).)

Poste, E. P.

STANDARDIZATION OF ENAMELED APPARATUS FOR CHEMICAL PURPOSES. *Chem. Met. Eng.*, **27**, 1016 (1922).—A paper presented at Eighth Chemical Exposition. Standardization of types of enamels to withstand varying degrees of corrosive action, materials of construction, uses, and methods of temperature control on apparatus are described. (*Ceram. Abs.*, **2**, 31 (1923).)

Poste, E. P.

HEAT TRANSMISSION IN ENAMEL-LINED APPARATUS. *Ind. Eng. Chem.*, **16**, 469 (1924).—A report of observations on a wide variety of types of enamel-lined equipment operated under a wide range of conditions. Typical cases are covered on commercial units to illustrate what may be expected under various conditions and from these and other data, the following over-all coefficients of heat transmission are given:

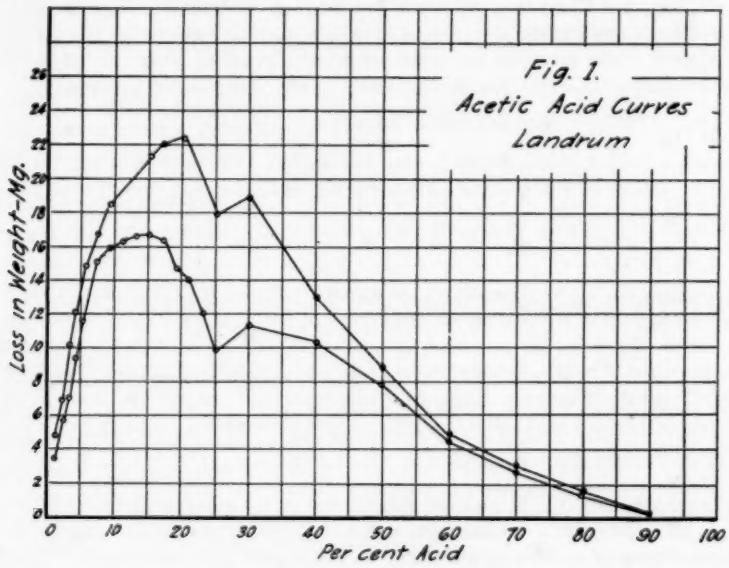
OVER-ALL COEFFICIENT OF HEAT TRANSMISSION

Conditions	Kg. cal./hr./ sq. M/°C	B.t.u./hr./ sq. ft./°F
Steam to water being heated	400–700	80–140
Hot water to water being heated	350	70
Steam to boiling water	700	140
Steam to a thick fruit product	160	32
Cooling water by cold water and by brine	200–600	40–120
Hot oil to oil being heated	65–140	13– 24
Hot oil to boiling water	150–200	30– 40
Steam to water being heated in tubular heaters	500–800	100–160
Steam being condensed to water in tubular condenser jacket	700	140

The thickness of the enamel coating, rather than the metal thickness, seems to be the determining factor in the over-all coefficients of heat transmission. The values stated are based on actual operating conditions. (*Ceram. Abs.*, **3**, 240, 280 (1924); *Chem. and Ind.*, **43B**, 541 (1924).)

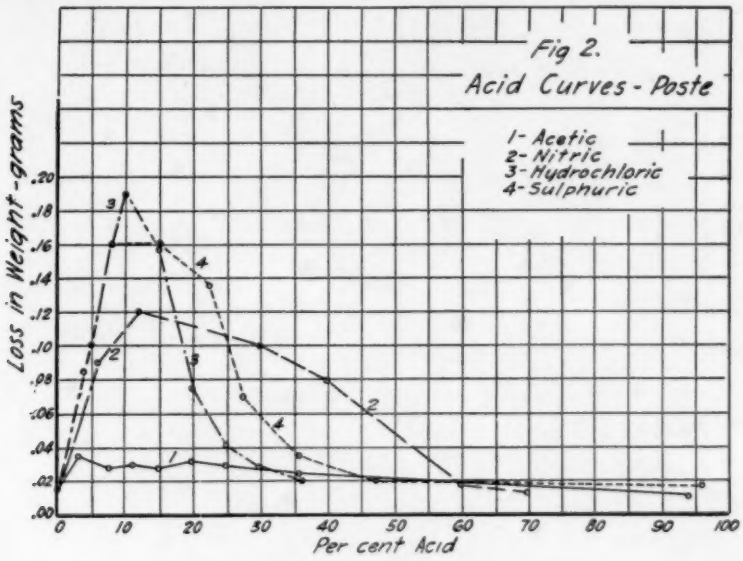
Poste, E. P.

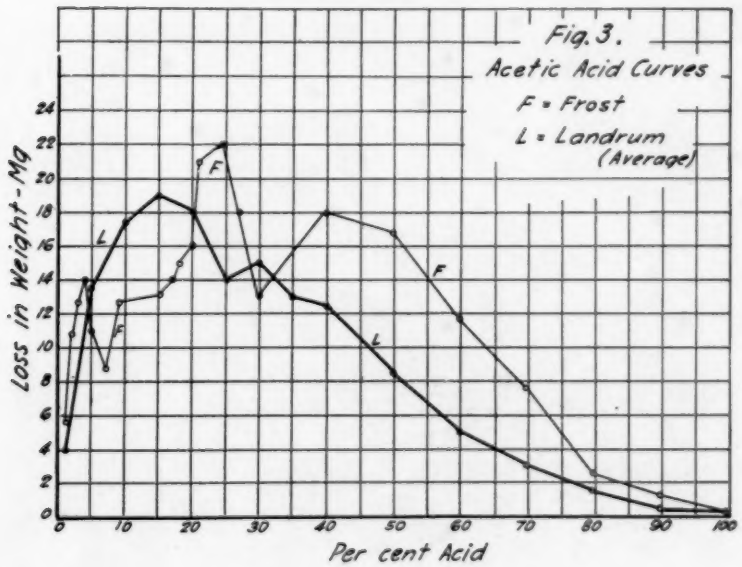
RELATIVE ACTION OF ACIDS ON ENAMELS. III. *Jour. Amer. Ceram. Soc.*, **2**, 32 (1919).—Dilute acetic acid is more active than the concentrated. Action at a maximum at 20%. At given concentrations citric and tartaric acids are more active on enamels



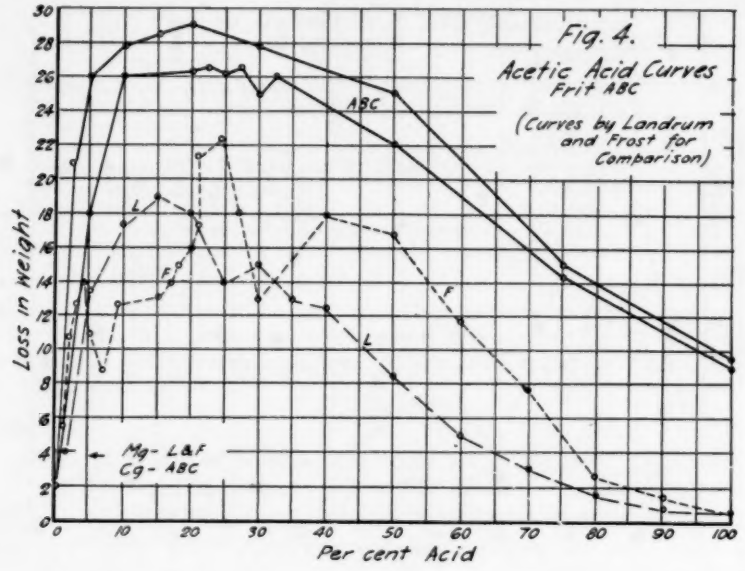
than acetic. Relative action of citric and tartaric acids at given concentrations appear to be about equal. The general shape of the curves for citric and tartaric acids is such

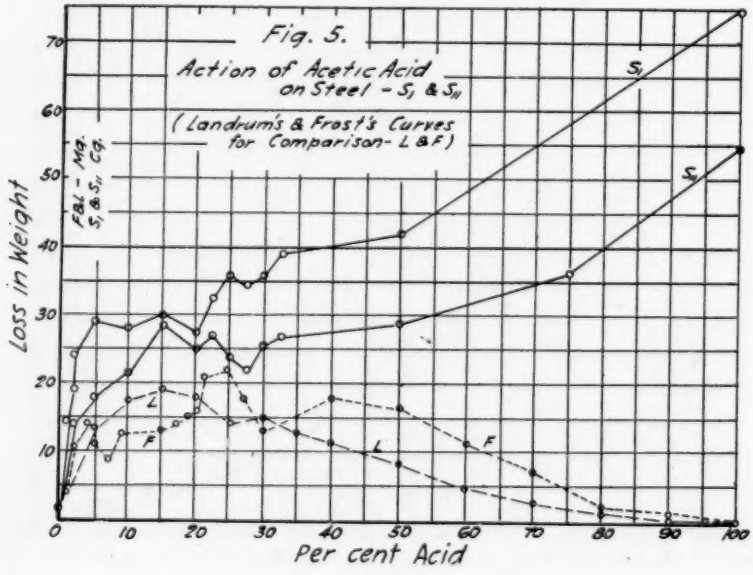
as to render slight errors in concentration above 10% of minor importance in terms of the difference in activity, *i.e.*, the curves from 10 to 50% are practically horizontal straight lines. As a basis of such work five frits were used. They were designated as Ex 1, Ex 2, A, B, and C. Ex 1 and Ex 2 were two experimental blue frits of low-acid resistance as compared with cooking-ware frits. A, B, and C were three commercial white frits submitted to the committee by three enameling companies. A mixture of



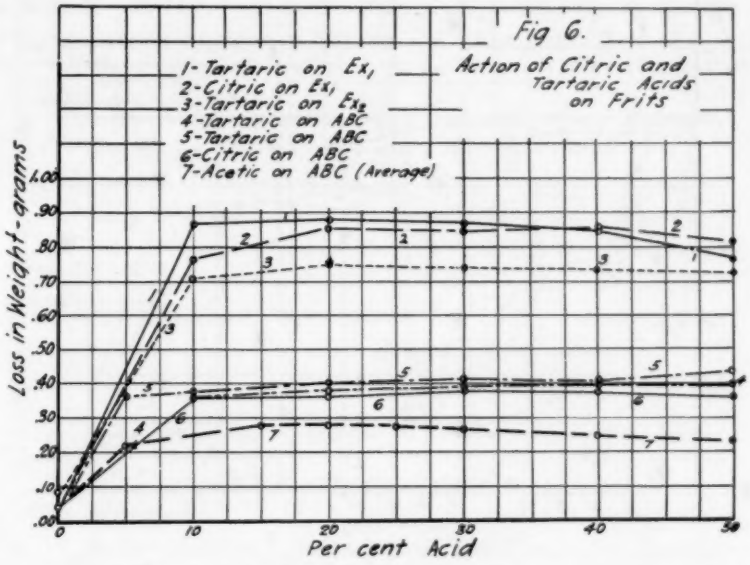


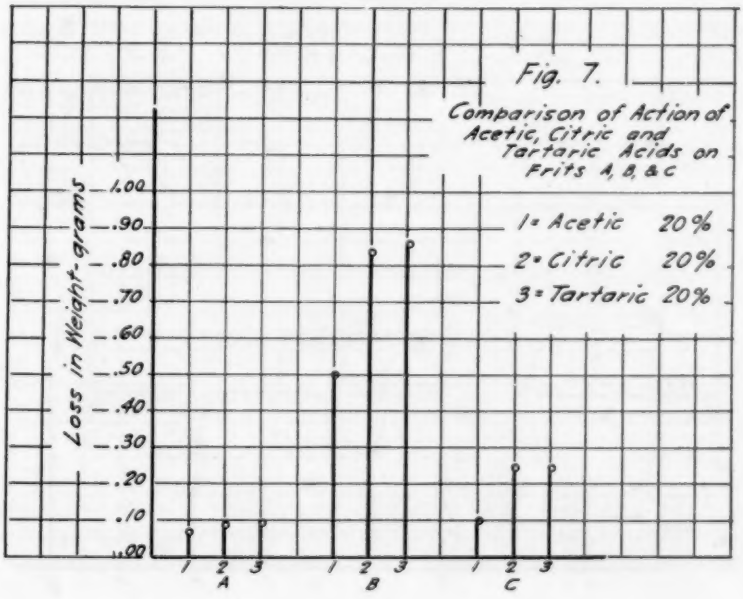
equal parts of these was designated as A, B, C. *Action of acetic acid:* In the results on samples of steel the numerical difference was due to a higher average temperature in one case than in the other. The severe action in higher concentrations is due to the corrosive action of acetic acid on steel. *Action of citric and tartaric acids:* Two general observations may be made. One is the fact that enamels of different acid resistance behave quite differently when subjected to the action of either citric or tartaric acid. The



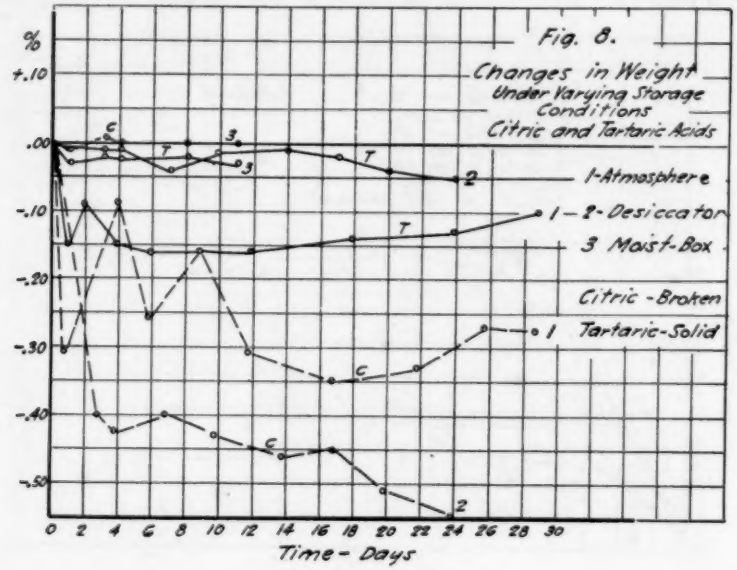


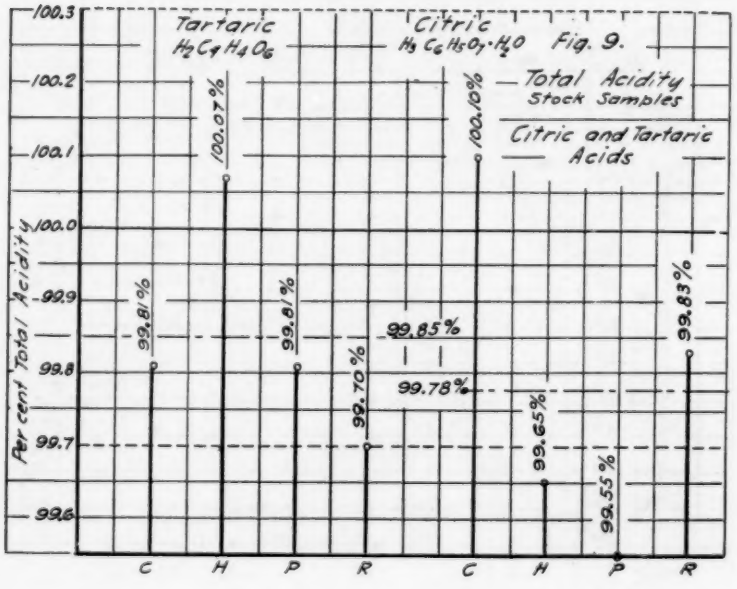
fact is evident from the characteristic difference between the curves for frits Ex 1 and Ex 2 and those for frits A, B, C. It is also apparent that the relative action of citric and tartaric acids on the combined frit ABC is not materially different and that in concentrations, from 10% up to saturation, the severity of the action is quite constant. It would seem that the above tests have established in a general way the nature of the action of citric and tartaric acids on the particular frits used and that the activity of





a 20% solution was quite high, without any radical changes, due to slight differences in acid concentrations in either direction being in evidence. The changes and variations on commercial samples of tartaric and citric acid were found to be very slight, and within the limits of error of the analytical methods used. (*Chem. Abs.*, **13**, 1136 (1919); *Chem. and Ind.*, **38A**, 287 (1919).)



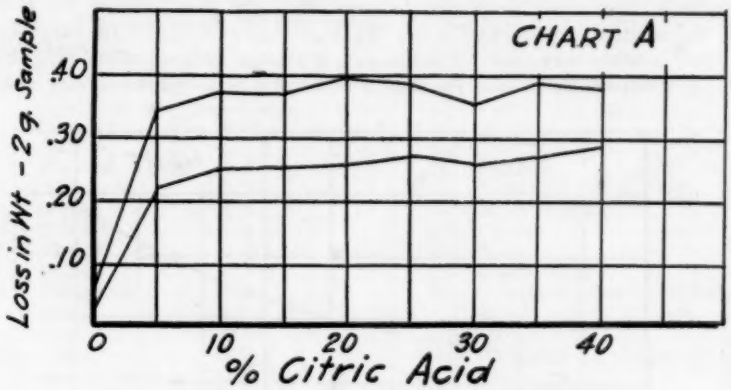


Poste, E. P.

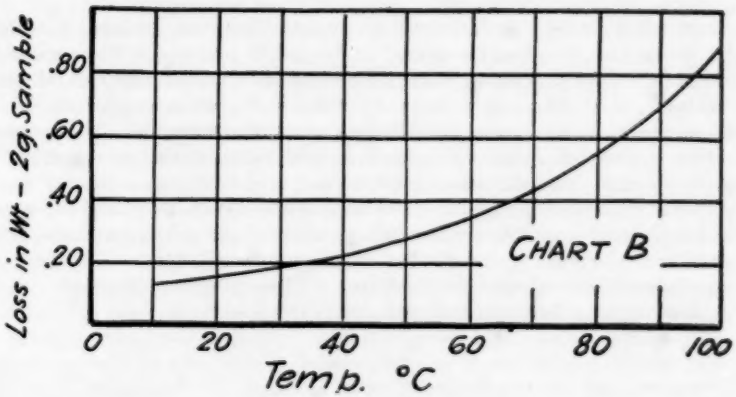
MANUFACTURE OF ENAMEL-LINED APPARATUS. *Jour. Amer. Ceram. Soc.*, **2**, 944 (1919).—A very good description of the manufacture of large apparatus with enamel lining. Article contains a large number of pictures showing different kinds of apparatus, and some illustrating points in the process. Methods of technical control are also given. (*Chem. Abs.*, **14**, 1744 (1920); *Chem. and Ind.*, **39A**, 336 (1920).)

Poste, E. P.

RELATIVE ACTION OF ACIDS ON ENAMELS. IV. *Jour. Amer. Ceram. Soc.*, **3**, 560 (1920).—This paper is the continuation of the work done on the action of acids on



enamels. It was the consensus of opinion of various food chemists that citric acid offers a fairer means of testing than does tartaric. Effect of acid on two different frits is given. The action is rather uniform at 15%, so this is taken as the desired strength for testing.

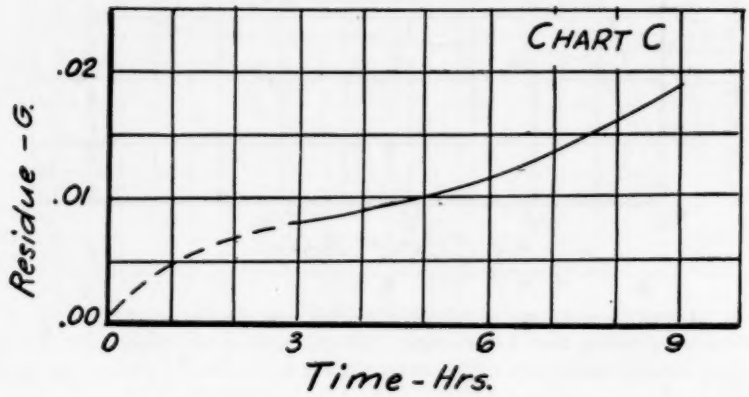


The effect of temperature is given, using 15% citric acid. Tests run for an hour at various temperatures using a reflux condenser. *Application to commercial ware:* Dishes were tested with standard acid solution (15%). After standing 24 hours, the solutions

from each were diluted to 500 cc. and ignitions made on the residue from 100 cc. portions. The results on one series were as follows:

Sample	Residue, gram
M3	0.0088
M4	0.0084
M5	0.0079

Possible modifications: The first variation attempted was shortening the time period. Three dishes were each filled with 200 cc. solution. The first was emptied after 3 hours, the second after 6 hours, and the third after 9 hours. Definite etching was noted in the first, with increased etching in the other two. One hundred cc. samples were taken from 500 cc. dilutions. The results are higher than those given above, this being partially due to a much higher laboratory temperature. The next variation was that of diluting the solution. Solutions $^1/_2$, $^1/_4$, $^1/_8$, $^1/_{16}$, $^1/_{32}$, and $^1/_{64}$ of the strength of the standard solution were used. The amounts of etching dropped off readily. Faint etchings were noted in the case of the more concentrated acid, but it was very difficult



to determine which, if any, dishes showed no etching. *Detection of etching:* Some finely ground charcoal was rubbed on the enamel on one side of each dish. This produced in all cases a definite discoloration of the etched portion but no discoloration of the enamel above the liquor line. The relative intensity of this discoloration was not proportional and could be varied by the manner in which the material was rubbed on. This suggested the necessity of some other means of producing a color effect, and a three-gram per liter solution of malachite green was used in a preliminary way on the same dishes. A small amount of this solution was placed in each of the dishes and allowed to stand five minutes and the dishes rinsed out. The resulting discoloration of the etched portion seemed to be reasonably proportional to the strength of the acids which had been in the dishes, and the unetched portion showed no discoloration. Discussion by J. B. Shaw. (*Chem. Abs.*, **14**, 3140 (1920); *Chem. and Ind.*, **39A**, 599 (1920).)

Poste, E. P.

METALLOGRAPHY OF THE OXYACETYLENE WELD AS EFFECTED BY ENAMELING. *Jour. Amer. Ceram Soc.*, **4**, 546 (1921).—Various observations in connection with the firing of enameled tanks have long indicated that the enameling operation involves the heating of the tanks to a sufficiently high temperature to effect the annealing of the welds. The time and temperature of enameling were such that they would produce very

thorough annealing on steels used in enamel work. The enameling operation furnishes thorough annealing of the welds producing structures which indicate desirable mechanical qualities, as compared with those suggested by the unenameled samples and often considered as characteristic of oxyacetylene welds. Microphotographs are used to illustrate different points. (*Chem. Abs.*, **16,** 150 (1922); *Chem. and Ind.*, **40A,** 848 (1921).)

Poste, E. P.

RELATIVE MERIT OF HEAT-RESISTING ALLOYS FOR ENAMEL-FIRING RACKS. *Jour. Amer. Ceram. Soc.*, **5,** 811 (1922).—Enamel-firing racks fail by oxidation and warpage. Several metals have been studied with regard to oxidation and warpage at a temperature from 1700 to 1800°F. These metals are listed in the order of increasing warpage and increasing oxidation. Actual data are given and comparisons are made by means of a chart. Conclusions are drawn in terms of the choice of rack material for firing heavy and light ware.

Resistance to warpage		Sag per hour (mm.)	Heat resistance (oxidation)	
(1)	Calcite	0.7	(1)	Thermalloy
(2)	Hardite	0.7	(2)	Hardite
(3)	Nichrome	1.0	(3)	Nichrome
(4)	Nickel	1.4	(4)	Rezistal (good)
(5)	Rezistal	1.8	(5)	Calcite
(6)	Thermalloy	2.5	(6)	Nickel
(7)	Misco	3.5	(7)	Misco (fair)
(8)	Monel metal	4.5	(8)	Calorized steel (indefinite, blistered)
(9)	Cast steel	5.0 (good)	(9)	Monel metal
(10)	Calorized	19.0	(10)	Cast steel
(11)	Steel (BOH)	22.0 (fair)	(11)	Cast iron
(12)	Cast iron	101.0 (very poor)	(12)	Steel (BOH) (poor)

Discussion by I. F. Cox (this *Bibliography*, p. 76). (*Chem. Abs.*, **17,** 193 (1923); *Chem. and Ind.*, **41A,** 983 (1922).)

Poste, E. P.

RELATIVE ACTION OF ACIDS ON ENAMELS. *Jour. Amer. Ceram. Soc.*, **6,** 689 (1923).—The work of the former Committee on Standardization of Tests is the starting point for the work in this paper. The action of a citric acid on different types of enamels is studied. The time required to produce first etching of cooking-ware enamels with 15% acid is investigated. The above lead to the conclusion that commercial cooking-ware enamels as a whole are readily etched by 15% citric acid and the degree of etching is not necessarily proportional to the time of action. The uses of 1% acetic acid and of a "spot" test are investigated including tests on commercial ware. The work as a whole brings out certain weaknesses of the possible methods of testing but does not result in the establishment of a satisfactory test. Various points have been placed on record that may add to the general knowledge regarding the action of acids on enamels. Further information with reference to the action of citric acid on different enamels has been brought out. Previous investigators have been checked in their findings that acid action on enamel surfaces is not necessarily proportional to time and suggested in this case the present impracticability of attempting to make use of a definite quantitative basis for acid action. The Bureau of Standards tentative test was criticized in regard to the acid named therein, but no satisfactory substitute was found. Certain tests on commercial ware including a spot test seemed to be of value as a means of quick results in the hands of one experienced in its use. (*Chem. Abs.*, **17,** 3765 (1923); *Chem. and Ind.*, **42A,** 776 (1923).)

Poste, E. P.

ANALYSIS OF SUSPENSION OF ENAMEL BY CLAY IN TERMS OF COLLOID THEORY. *Jour. Amer. Ceram Soc.*, **8,** 232 (1925).—As a batch of finely-ground enamel with clay and water leaves the mill, it is probably a mixture of noncolloidal enamel and clay particles, and water with such materials in solution as may have dissolved. With the above or any other theory as the working basis, it becomes necessary to have a correct conception of the physical properties of the enamel slip as a means of making observations experimentally and correlating them with the practical phases of the problem. E. C. Bingham has suggested that the old habit of working in terms of a viscous liquid is wrong and that we should think of enamel slip as a plastic solid whose behavior is to be judged in terms of "mobility" and "yield point." This line of reasoning as applied in certain industries has brought most encouraging results. R. D. Cooke has made a preliminary application to the problem and more work along this line may be expected to throw much light. The purpose of this presentation has not been to proclaim any new ideas or to herald the results of new accomplishment, but to stimulate thought and research of a fundamental nature. *Enamelist,* **2** [5], 7 (1925); *Chem. Abs.*, **19,** 1762 (1925); *Chem. and Ind.*, **44B,** 503 (1925).)

Poste, E. P.

RELATIVE ACTION OF ACIDS ON ENAMEL. *Trans. Amer. Ceram. Soc.*, **17,** 137 (1915).—Two grams of powdered frit were weighed into 400-cc. beaker, 100 cc. of acid added, contents of beaker thoroughly stirred, covered with a watch glass, and allowed to stand 24 hours at laboratory temperature which was practically constant. The importance of considering the area of the surfaces exposed is very clearly shown by the results of the tests on different-sized particles. Thus Sample A (particles passed through 50-mesh, retained on 100-mesh) had a loss of 2.61%; Sample B (particles passed through 200-mesh) had a loss of 11.65%. Twelve per cent hydrochloric acid was used under conditions as noted above. The powdered frit used gave the following results on standard sieves: passing 50-mesh, retained on 100-, 4.90%; passing 100-mesh, retained on 200-, 33.90%; passing 200-mesh, 61.20%. Discussions by Staley, Bole, Landrum, and Shaw. (*Chem. Abs.*, **10,** 513 (1916); *Chem. and Ind.*, **36,** 879 (1917).)

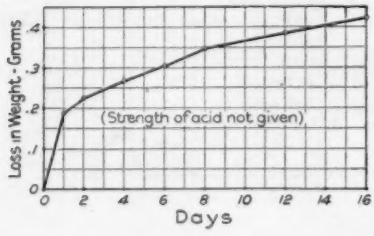


FIG. 1.—Loss in weight, 2-gram sample plotted against time.

Poste, E. P.

HEAT TRANSMISSION OF ENAMEL. *Trans. Amer. Ceram. Soc.*, **18,** 570 (1916).—Enamel coating on steel produces an appreciable retarding effect on heat transmissions, which is but slight with hot water as the heating medium but increases as the heating medium is steam under rising pressure. Experience with commercial apparatus leads to the conclusion that on larger units the difference between copper and enameled steel is not so great as would be concluded from the above tests on an experimental scale. (*Chem. Abs.*, **11,** 284 (1917); *Chem. and Ind.*, **36,** 718 (1917).)

Poste, E. P.

ENAMEL SURFACES UNDER THE MICROSCOPE. *Trans. Amer. Ceram. Soc.*, **19,** 146 (1917).—A marked difference in physical condition may be brought about by variations in treatment of a given frit, and under commercial conditions such variations

do exist. If the enamel is rather lightly fired, the major portion seems to fuse to a matrix of glass containing fine bubbles, and particles of unfused material in suspension. No doubt this unfused material consists essentially of clay or other of the more refractory mill additions. If the enamel is fired to about normal degree, this unfused material practically disappears and the minute bubbles seem to run together, forming larger units and leaving greater masses of glossy materials between. On further firing, the bubbles continue to combine until they become of sufficient size to produce surface pitting which can be detected by the naked eye. There are apparently chemical reactions which take place resulting in the formation of gases giving rise to this increasing porosity. (Discussion by J. B. Shaw.) (*Chem. Abs.*, **12**, 523 (1918); *Chem. and Ind.*, **37A**, 513 (1918).)

Poste, E. P.

RELATIVE ACTION OF ACIDS ON ENAMEL. II. *Trans. Amer. Ceram. Soc.*, **18**, 762 (1916).—Result of work done on suggestions brought out in discussion of previous

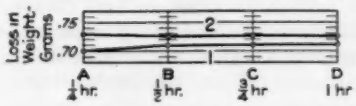


FIG. 1.—Effect of fineness of sample. Loss of weight on 2-gram sample plotted against time of grinding. (1) sample passing 80-mesh retained on 100-mesh; (2) sample passing 100-mesh, retained on 150-mesh.

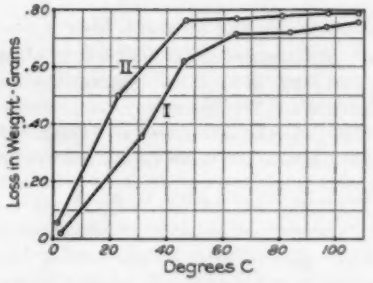


FIG. 2.—Loss in weight, 2-gram sample plotted against temperature. I, made by mixing 100–150-mesh portions of A, B, C, and D from above. II, 100–150-mesh portion of fruit from another formula.

paper. This series of tests leads to the conclusion that the use of a narrow limit of particle size would not introduce variations due to differences of average fineness of the entire sample which would materially affect the results. Method used in noting effect of temperature: two green samples placed in flask containing 13.6% HCl under reflux condenser, and then heated or cooled to desired temperature. (*Chem. Abs.*, **11**, 282 (1917); *Chem. and Ind.*, **36**, 879 (1917).)

Poste, E. P.

CHEMICAL CONDITION OF MANGANESE IN GLASS WHEN USED AS A DECOLORIZER AND FACTORS OF FURNACE CONDITIONS AFFECTING IT. *Trans. Amer. Ceram. Soc.*, **19**, 375 (1917).—Data are given to show that under the conditions existing in the enamel furnace, the amount of oxygen present in contact with the enamel when it matures has a direct bearing on the condition existing within the enamel insofar as the color-producing power of the cobalt is concerned. Apparently it is the highly oxidized material that gives the pleasing blue color while the reduced form which results from low oxygen gives a very greenish yellow color or some other coloring effect exerts itself which is not covered up by the cobalt blue.

***Poste, E. P.**

MICROSCOPIC STUDY OF GROUND-COAT AND COVER-COAT ENAMEL REACTIONS. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 38).

EFFECT OF SOURCES OF PIG IRON UPON ENAMELING OF CAST IRON. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 40).

MUFFLE ATMOSPHERE ON FIRING ENAMELS. (Discussion.) See this *Bibliography*, p. 43.

ZIRCONIA IN ENAMELS (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 41).

PLASTICITY. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 42).

EFFECT OF VARIATION IN COMPOSITION OF GROUND COATS FOR SHEET-IRON ENAMELS. See Danielson, R. R. (this *Bibliography*, p. 83.)

ENAMEL SYMPOSIUM. See Jaeger, F. G. (this *Bibliography*, p. 161).

Poste, E. P., and Donauer, Max

ENAMELED APPARATUS FROM A CHEMICAL ENGINEERING STANDPOINT. *Ind. Eng. Chem.*, **15,** 469 (1923).—Enameled apparatus is finding increased uses in chemical processes. The enameler must produce an enamel that will meet its special requirement fully. As the severity of acid corrosion becomes greater it is necessary to limit the size and shape of the vessel to insure a perfect enamel coating. (*Ceram. Abs.*, **3,** 280 (1924).)

Poste, E. P., and Rice, B. A.

EFFECT OF DEGREE OF SMELTING UPON PROPERTIES OF FRIT. *Jour. Amer. Ceram. Soc.*, **1,** 221 (1918).—Formula not given. Fairly resistant to acids. The raw materials, properly mixed, were placed in a tilting smelter which had been preheated in the usual manner. As soon as the material had reached a fairly uniform condition of fusion and after thorough stirring, a small portion of the enamel was withdrawn from the smelter, the total time to reach this condition being taken as unity. This enamel was designated as *A*. In like manner, samples were poured from the smelter at the following time intervals based on the former as unity: $1^1/_2$, 2, $2^1/_2$, 3, $3^1/_2$, the samples being designated *B*, *C*, *D*, *E*, and *F*, respectively. *Results of chemical analyses:* Assuming SiO_2 is constant (after *F* is evolved) there has been a gradual loss in the amount of CaO and Al_2O_3, a greater loss in K_2O, and a very material loss in the amounts of Na_2O and B_2O_3. (Loss is the difference between theoretical formula value and the amount actually found.) Deformation temperature (temperature at which the tip of a cone made of 200-mesh powder and organic binder will first move) increases from *A* to *F*. Deformation range (range from temperature at which tip first moves to temperature at which the tip of cone was just touching the asbestos board upon which the cones were mounted) also increases from *A* to *F*. Coefficient of linear expansion (calculated) decreases from *A* to *D* and is practically constant from *D* to *F*. By drawing a hair of enamel from a batch during smelting there is a period during which the hair will contain particles of unfused material and will be quite brittle. As the mass reaches a quiet fusion, the brittleness of this hair greatly diminishes and finally a point of maximum toughness is reached, beyond which it again becomes brittle. For this particular enamel this point of maximum toughness is about $^1/_3$ beyond the point *C*. There was a marked increase in acid resistance from *A* to *F*, but it would appear that the resulting objectionable physical properties would make it impossible to realize this increase in chemical resistance. Discussions by J. B. Shaw, R. R. Danielson, and H. F. Staley. (*Chem. Abs.*, **12,** 2421 (1918); *Chem. and Ind.*, **38A,** 15 (1919).)

Pottery Gazette and Glass Trade Review, **50**, 419 (1925).

C. F. B. PATENT ENAMEL KILN.—The novel feature of this kiln consists chiefly in the formation of a ridge on the back vertical edge of the quarries, which are thus enabled to mortise into recessed midfeather brick. The latter are built up in the kiln leaving a channel all the way around, and a sinuous course is provided, along which the gases have to pass, it being impossible for them to enter the kiln chamber. Any existing kiln can be readily converted to the new system by the replacement of the quarries and midfeather brick. (*Ceram. Abs.*, **4**, 172 (1925).)

Powell, A. L., and Summers, J. A.

COMMERCIAL PHOTOMETRY. *Gen. Elec. Rev.*, **24**, 50 (1921).—A review with a very useful bibliography appended. *Jour. Amer. Ceram. Soc.* (Abs.), **4**, 317 (1921).

Pr. Mech. J., 3 S, **4**, 296.

IMPROVEMENT IN MANUFACTURE OF ENAMELED IRONWARE. (*Rep. der Tech. Lit.*, p. 405 (1869–1873).)

Preece, A.

GAS FURNACES AND MUFFLES FOR ENAMELING METALLIC WARE. British Pat. 19,800, Sept. 8, 1896.—The gas from an ordinary producer-furnace is passed over a brick arch into a flue running under the muffle (which is one designed for use in enameling metallic articles), and opening at one side into a number of lateral passages leading via a series of upright flues, into an arched flue over the muffle. This arched space is constricted on the opposite side to prevent the gases from escaping too freely through the descending flues there situated, and leading to the chimney. To secure equalization of heat in the bottom flue, the lateral openings decrease in size toward the furnace end of the muffle. A series of air-flues keeps the firebrick arch and the bricks at the bottom and sides of the gas flues cool, the heated air passing into the arched flue and there producing intense combustion. (*Chem. and Ind.*, **16**, 738 (1897).)

Prentice, E. B.

INSULATION INCREASES FURNACE EFFICIENCY. *Ceram. Ind.*, **4**, 110 (1925).—Conclusions by P. and those drawn from data coincide on: (1) Oil is the most applicable fuel for both firing and smelting. (2) A furnace, if possible, should be designed for one fuel only and more attention should be given to obtaining proper combustion. (3) More adequate bracing and better foundations for the furnaces will eliminate many early failures. (4) The muffle type of furnace is gaining prestige, especially in the classes of work which permit the use of speed forks. (5) The recent door sealing devices are excellent. (6) Insulation is doing much to increase the efficiency of furnaces. (7) Good engineering requires an adequate factor of safety. An adequate factor of safety in the refractories used will prove economical in the long run. (8) While results are somewhat uncertain and in some cases contradictory, time will probably establish the recuperator as a part of the enamel firing furnace, as well as the smelter, because it is correct from an engineering standpoint. (9) Frequent checkups by the furnaceman, as to the number of B.t.u.'s required to fire ware over a definite period and the B.t.u. actually put into the furnace in fuel, will give excellent information as to how efficiently it is operating. (*Ceram. Abs.*, **4**, 126 (1925).)

Prentice, E. B.

FLUX BLOCK OR FIRE BRICK FOR SMELTERS? *Ceram. Ind.*, **5**, 235 (1925).—In a test run, two smelters melting the same enamel were lined with a lining of the same composition and thickness. In the first, the lining was composed of large flux blocks, in

the second smelter, the lining was composed of 9-in. brick and shapes. The actual operating data showed that the second smelter melted 15.2% more heats than the first, while the cost of the lining for the second smelter was slightly less than two-thirds the cost of the flux block lining. The superiority of the brick was undoubtedly due to the more dense, compact structure developed by mechanical pressure on the press in manufacture, an advantage which the flux blocks did not receive. The difference in cost is due to the fact that the brick and shapes can be made in an established cycle of manufacture rather than by the tedious hand operation.

Prentice, E. B.

MUFFLES FOR ENAMEL INDUSTRIES. *Enamelist*, **1** [9], 6 (1924).—*Materials* (prerequisites to consider): (*a*) refractoriness, (*b*) thermal conductivity, and (*c*) low specific heat. *Design:* Radiation is chief means by which heat reaches the ware. It depends solely upon surface. Modern muffle contains about one-half the material formerly used. This means a great saving in fuel. In order to reduce the thickness of side walls and crown in above manner, it is necessary to make tiles from the highest grade aluminous material. Piers and supports must resist (*a*) shrinkage, (*b*) deformation, (*c*) scorification, and (*d*) high temperatures. High-grade refractory coating will prolong the life of the refractories to a great extent.

Prentice, E. B.

SELECTING PROPER SMELTER LINING. *Enamelist*, **2** [2], 4 (1924).—It is desirous to secure a lining as insoluble in the melt as possible. The constituent in fire brick tending to render it insoluble is alumina. Service data show that the higher the alumina content, the less soluble at a given temperature.

Prentice, E. B.

FULL MUFFLE VS. NEWER TYPES OF MUFFLE. *Enamelist*, **2** [3], 17 (1924).—Short comparison of the two types. (*Fuels and Fur.*, **2**, 20 (1925); *Ceram. Abs.*, **4**, 183 (1925).)

Prentice, E. B., and Christman, H. M.

PRACTICAL ENAMEL SMELTER LINING. *Enamelist*, **2** [10], 12 (1925).—Most enamelers have abandoned the use of flux blocks and are using standard 9-in. brick and shapes. These should be of established chemical and physical structure best suited to resist the action of the enamel and to minimize the effect of the numerous joints by taking special pains to have these brick come through the manufacturing process very true in shape and size. A comparison test between a smelter lined with flux block and one lined with 9-in. brick and shapes showed the smelter with the 9-in. brick lining to give 15.2% more heats and cost two-thirds the cost of the flux block lining.

Prentice, E. B., and Christman, H. M.

PRACTICAL ENAMEL SMELTER LININGS. *Fuels and Fur.*, **3**, 1280 (1925).—A lining of standard shapes is suggested to take the place of flux blocks now in general use. In using the 9-in. standard shapes, however, care should be taken that the refractory material is such that it will resist the action of the enamel and that they be as true to shape as possible so as to minimize the effect of many joints. All precautions should be taken to secure a thin joint. By using the standard shapes and brick the enamel man can rest assured that he can secure a lining at a moment's notice. (*Ceram. Abs.*, **5**, 46 (1926).)

Prentiss, F. L.

ENAMELING CAST-IRON AND STEEL MATERIALS. *Iron Age*, **109**, 13 (1922).—P. describes the methods and apparatus used in enameling cast-iron and steel tanks, etc.,

at the plant of the Elyria Enamel Products Co. (Illustrated.) (*Ceram. Abs.*, **1**, 191 (1922); *Chem. Abs.*, **16**, 1304 (1922).)

Preusser, F.

MAKING OPAQUING AND ENAMELING COMPOUNDS AND THE PRODUCT. U. S. Pat. 1,314,831, Sept. 2, 1919.—The object of this invention is to reduce the quantity of the expensive opacifying oxides such as those of tin, zirconium, and antimony used in glazes and enamels and at the same time effect the same degree of opaqueness. An opacifier meeting these requirements is said to be obtained by the mutual decomposition and reaction of two groups of enameling substances, one of these being the turbidity-producing or opaquing salts and compounds of the alkaline earth metals and some earth metals, the oxides of which do not possess this quality, while the other group consists of the opaquing oxides or compounds of the so-called border elements, *i.e.*, those mostly tetravalent and partly trivalent comparatively, easily fusible, metallic elements, which partake of the characteristics of metals as well as metalloids, such for instance as tin, titanium, zirconium, thorium, and to some extent bismuth, arsenic, and cerium. These two groups must be chemically combined. This combination may be effected in either the dry or the wet way. Phosphates, silicates, and aluminates of the latter-mentioned metals which form opaquing oxides and chemical combinations thereof with the alkali earth metals are thus produced in which, owing to the mutual decomposition which has taken place, the clouding oxides such as SiO_2 are contained in an exceedingly fine, almost colloidal distribution, similar to a dyeing agent, so that this artificial product and the opaquing and enameling results thereby produced are entirely different from the natural silicates of the rare earth metals and the very weak clouding effects produced by them. Several examples are given; *e.g.*, proceeding in the wet way, $ZrOCl_2$ 55 parts, $MgSO_4$ 2.5 parts, and $K_2Al_2(SO_4)_4\ 24H_2O$ (potash alum) 5 parts, are dissolved in water and treated with a solution of Na_3PO_4 20 parts, Na_4SiO_4 5 parts, and NaOH 10 parts. A complex body containing silicates and phosphates of zirconium and aluminum with some phosphate and silicate of magnesium is formed. The soluble and volatile decomposition products are washed out. Proceeding in the dry way $Zr(OH)_2$, Al_2O_3 or $Al(OH)_3$, and $Ca_3(PO_4)_2$ are mixed and melted, and, if necessary, a small amount of $MgCO_3$ or $Na_2B_4O_7$ may be added to assist in the decomposition of the phosphate as well as for the purpose of regulating the melting of the mass and the adhesive quality of the enamel. P. states that these compounds may be used alone as glazes or in combination with ordinary fritted glazes as opacifiers. (*Jour. Amer. Ceram. Soc.* (Abs.), **2**, 927 (1919); *Chem. Abs.*, **13**, 2748 (1919); *Chem. and Ind.*, **38A**, 820 (1919).)

Prichard, R. H.

ENAMELING PLATES. U. S. Pat. 1,381,736, June 14, 1921.—The process for enameling plates, etc., which consists in alternately applying enamel and passing the sheets flatwise through drying zones in which the sheets are exposed to a forced draft of heated air, and finally discharging them for further treatment.

•Prince, E. S.

RELATION OF FINENESS OF GRINDING TO OPACITY IN WHITE ENAMELS. See Sweely, B. T. (this *Bibliography*, p. 308).

Pumphrey, Preston H.

MAKING SHEETS FOR THE PORCELAIN ENAMELER. *Enamelist*, **1** [8], 6 (1924).—Description of the manufacture of uniform base metal for enameling purposes.

Purdy, R. C.

DISCUSSION OF PAPER ON COLLOID MATTER OF CLAY. *Trans. Amer. Ceram. Soc.*, **11**, 555 (1909).—Written discussion on paper by H. E. Ashley.

Purdy, R. C.

COBALT IN GROUND-COAT ENAMELS FOR SHEET STEEL. See Binns, C. F. (this *Bibliography*, p. 192).

ANNEALING PORCELAIN PARTS PROVED TO BE INTERESTING. See *Enamelist* (this *Bibliography*, p. 106).

Puscher

ENAMEL COVERING FOR ROLLED ZINC-PLATES WITHOUT USE OF COLOR. *Erfind.*, **10**, 356. (*Rep. der Tech. Lit.*, p. 119 (1882–1884).)

Pütsch, Ziebarth

OVEN FOR MANUFACTURE OF ENAMEL FOR IRON VESSELS. *Bull d'enc.*, p. 54, 1867. (*Rep. der Tech. Lit.*, p. 306 (1854–1868).)

Quay, Paul Q.

STANDARD SHOP PRACTICE. *Enamelist*, **1** [7], 4 (1924).—Short article giving advantages of having shop practice standardized.

***Quick Meal Stove Co.**

LABOR REDUCTION IN PICKLING ROOM. See *Ceram. Ind.* (this *Bibliography*, p. 55).

Quimby, E. C.

ENAMELED WARE, ETC. U. S. Pat. 250,102, Nov. 29, 1881.—Method consists in first coating the body of the article with glaze of some suitable color, firing the same, then painting or otherwise placing thereon suitable ornaments in relief in some contrasting color, and again firing.

Quimby, E. C., and Whiting, J. C.

ENAMELING METALWARE. U. S. Pat. 184,798, Nov. 28, 1876.—Method for causing the enamel to adhere upon the turned-over edges of the enameled sheet-iron vessels, consisting in repeating the operation of annealing and pickling after the edge has been turned, and prior to the application of the enamel.

Quimby, H. D.

ENAMELING SHEET METAL AND COMPOUND THEREFOR. U. S. Pat. 519,968, May 15, 1894.—That improvement in the art of enameling metal or metalware, which consists in first cleaning and roughening the surface of the metal or ware by a strong acid solution, next allowing it to dry, then dipping or coating the same with a glaze composed of the ingredients and substantially in the proportions named; allowing it to dry at the usual temperature of the atmosphere and then firing. The compound for enameling metal or metalware consisting of silica, feldspar, borax, calcium fluoride, calcium phosphate, pipe clay, and mineral salts.

Quimby and Whiting

INNOVATION IN MANUFACTURE OF ENAMELED IRONWARE. German Pat. 1816 (1877). (*Rep. der Tech. Lit.*, p. 76 (1877).)

Raetz

ENAMEL FOR CAST- AND WROUGHT-IRON. *Pharm. Centralh.*, **20**, 43; *Erfind.*, **6**, 137; *Met. ind.*, **3**, 172. (*Rep. der Tech. Lit.*, p. 142 (1879–1881).)

***Randau, Paul**

REFERENCE BOOKS ON ENAMELS. See *Jour. Amer. Ceram. Soc.* (this *Bibliography*, p. 166).

Raphelis-Soissan L. de

ENAMELING. British Pat., 982,788, July 3, 1922.—To support and fix the enamel powder on metal the articles are coated with a porous noncarbonizing substance such as asbestos, mica, pumice stone, or infusorial earth, in powder, fiber, or sheet form, and the enamel is painted thereon or may be previously incorporated therewith. The articles are then shaped and fired. (*Ceram. Abs.*, **2,** 32 (1923); *Chem. Abs.*, **16,** 4318 (1922); *Chem. and Ind.*, **42A,** 777 (1923).)

Raphelis-Soissan, L. de

INSULATING ENAMEL ON WIRES, ETC. U. S. Pat. 1,495,632, May 27, 1924.—Wire etc., to be coated with insulating enamel is first given a ground stratum of a flexible porous substance, *e.g.*, asbestos, powdered enamel is applied to this, shaped and heated to the melting point to produce an overlying enamel coating. See British Pat. 182,788 (1922). (*Ceram. Abs.*, **3,** 281 (1924); *Chem. Abs.*, **18,** 2230 (1924); *Chem. and Ind.*, **43B,** 598 (1924).)

Rapoport, J.

MANUFACTURE OF ENAMELED ARTICLES. British Pat. 18,014, Sept. 9, 1901.—In this process, the powdered colors are applied to the object to be enameled in small heaps placed side by side, or in separate or mixed layers, and so arranged that in the kiln the colors shall be on the highest part of the object and will consequently when fused flow over it. More powder should be taken than is required to cover the surface treated, the excess being allowed to drain off. (*Chem. and Ind.*, **20,** 1211 (1901).)

***Rappe**

MANUFACTURE OF AN OPAQUE ENAMEL. See Rickmann (this *Bibliography*, p. 257).

Rasser, E. O.

ENAMEL COLORS. *Kunststoffe*, **16,** 218 (1926).—The technic of glass painting with enamel colors is outlined. Compositions of fluxes and various colored enamels of proved merit are given. (*Ceram. Abs.*, **6,** 133 (1927); *Chem. Abs.*, **21,** 634 (1927).)

***Rath, W.**

SURFACE TENSION OF CLAY SLIP. See Ostwald, W. (this *Bibliography*, p. 229).

Read, Henry L.

GAS-FIRED ENAMELING FURNACES FOR CAST IRON. *Jour. Amer. Ceram. Soc.*, **9,** 797 (1926).—A comparison is made of gas-fired and electrically-heated glass, enamel ovens. Description of equipment, data on output fuel costs, and upkeep are given. The best performance of any of the electrics was an output at the rate of 35 tubs in 8 hours at 1820°F. This is equivalent to one tub every 13 minutes and 42.8 seconds. Under corresponding conditions the gas furnace averaged one tub in 13 minutes and 22.5 seconds at 1825°F. The capacity of the gas furnace was therefore superior to that of the electrics. A heat balance of the gas furnace is given as follows:

	Per cent
Heat absorbed in work	28.3
Heat lost in wall radiation	14.1
Heat lost in open door radiation	2.4
Heat lost in flue gases leaving recuperator	22.7
Heat lost in flue gases leaving open door	1.6
Heat given up to air in recuperator	30.9
	100.0

(*Ceram. Abs.*, **6**, 50 (1927); *Chem. Abs.*, **21**, 635 (1927); *Chem. and Ind.*, **46B**, 749 (1927).)

Reed, J. C.

PROCESS AND APPARATUS FOR ENAMELING. French Pat. 334,506, Aug. 8, 1903.—The metal object to be enameled, as a bath pan for instance, is transferred from the furnace to a metal receptacle having a movable bottom, and a closely-fitting cover, carrying the mechanism for feeding and distributing the enamel, and protected on all sides from heat radiation by asbestos packing, etc. A predetermined quantity of the enamel is placed in a hopper, and, by mechanism operated by an electric motor, is fed regularly into a verticle pipe descending a certain distance into the pan to be enameled, where, by rapid rotation and the action of distributing wings, the enamel is dispersed centrifugally, and also falls about in such a manner as to cover the internal surface of the pan uniformly. It is a feature of the invention that the object to be enameled is maintained immovable, while the enamel is mechanically supplied within a space closed from the air, and so protected against loss of heat that the enameling is effected at a single process without the necessity for reheating. (*Chem. and Ind.*, **23**, 63 (1904).)

Rehm, T.

ACID-RESISTING ENAMEL FOR SANITARY WARE. *Ceram. Ind.*, **8**, 574 (1927).—Short note on this subject.

***Reinecker, H. P.**

PRODUCTION OF WHITE ENAMELS FOR COPPER. See Danielson, R. R. (this *Bibliography*, p. 87).

WET-PROCESS ENAMELS FOR CAST IRON. See Danielson, R. R. (this *Bibliography*, pp. 38 and 87).

***Reinicke, F.**

ORIGIN OF IMPRESSION OF LUSTER. See Zocher, H. (this *Bibliography*, p. 345).

Rennerfelt, I.

ELECTRIC FURNACE. U. S. Pat. 1,313,834, Aug. 19, 1919.—The furnace is adapted to melting enamels in crucibles. (*Chem. Abs.*, **13**, 2642 (1919).)

Rev. Chim. Ind., **19**, 160.

RECOVERY AND UTILIZATION OF ENAMEL WASTES.—Not over 20% should be added to a new mixture of the same nature; it is a practice to add all sorts to the first coat. Such a practice is strongly objected to. (*Chem. Abs.*, **2**, 2718 (1908).)

Rewald, B.

USE OF ANTIMONY IN ENAMEL INDUSTRY. *Chem. Ztg.*, **48**, 280 (1924).—While tin oxide is the most commonly used opacifier, antimony has lately gained wider recognition. In many countries the use of antimony in technical enamels is forbidden on account of the danger to health. But if the antimony is properly fritted there is no danger and its use should not be forbidden. (*Ceram. Abs.*, **3**, 313 (1924); *Chem. Abs.*, **18**, 2589 (1924).)

•Rewald, B.

ANTIMONY OXIDE. See Wohlgemuth and Rewald, *Chem. Trade J. and Chem. Eng.* (this *Bibliography*, p. 65).

Rhead, Frederick H.

ITALIAN MAJOLICA PROCESS AND PAINTING OVER TIN ENAMELS. *Bull. Amer. Ceram. Soc.*, **1**, 177 (1922).—Reference is made to historical types. Practical conditions are discussed, types of glazes are given, and methods of application are outlined. There are also comments in connection with one-fire products.

Rhodes, G. J.

ENAMELING CAST IRON. Brit. Pat. 2315, May 7, 1883.—In applying enamels directly to the surface of cast iron as heretofore practiced, when the enamel, which is applied either in a liquid state or in the form of powder, is being fired to produce a glazed surface, the surface becomes covered with bubbles or blisters caused by the expulsion, under the action of heat, in the muffle of the gases imprisoned in the iron, thereby impairing the appearance of the enamel, and rendering it useless as a protection to the iron from rust. To prevent the formation of these bubbles or blisters, R. expels nearly the whole of the gas from the pores of the iron, and partially fills the pores with oxide of iron, by subjecting the iron to the Bower-Barff process before proceeding to enamel it. (*Chem. and Ind.*, **3**, 111 (1884).)

Rice, B. A.

DEFORMATION STUDIES OF SILICATES AND ALUMINUM SILICATES OF THE ALKALIS. *Jour. Amer. Ceram. Soc.*, **6**, 525 (1923).—This investigation includes studies of the two ternary systems K_2O–Al_2O_3–SiO_2 and Na_2O–Al_2O_3–SiO_2. In each system two areas of low fusibility were found: one including members high in alkali, low in silica and alumina; the other including those high in silica, low in alkali and alumina. In both systems the high silica area was the one studied in detail as being of more practical ceramic value. On each triaxial three eutectics (two binary and one ternary) were established. They had the following compositions:

Per cent			Molecular			Approx. deformation, °C
K_2O	Al_2O_3	SiO_2	K_2O	Al_2O_3	SiO_2	
55.0		45.0	1.00		1.291	780
17.5		82.5	1.00		7.43	880
17.4	5.2	77.4	1.00	0.276	6.978	870
Na_2O	Al_2O_3	SiO_2	Na_2O	Al_2O_3	SiO_2	
51.5		48.5	1.00		0.972	830
18.4		81.6	1.00		4.579	860
17.5	5.4	77.1	1.00	0.185	4.55	800

The terms eutectic and deformation eutectic are used in this paper to designate those compositions which require the lowest temperature to complete deformation when uniformly heated with other compositions in the manner outlined. Deformation was judged by the same method used with standard pyrometric cones. Conclusions: (*Potassium series.*) (1) The members toward the high K_2O end of the triaxial were very deliquescent. They became soft and gummy on standing a short time. (2) Two deformation eutectics were noted on the straight line between K_2O and SiO_2. (*a*) 55% K_2O, 45% SiO_2, 780°C; (*b*) 17.5% K_2O, 82.5% SiO_2, 870°C. (3) A ternary deformation eutectic was found of the composition: 17.41% K_2O, 5.16% Al_2O_3, 77.43% SiO_2. (4) This ternary eutectic has a much higher SiO_2 content and lower Al_2O_3 content than any natural potassium aluminum silicate mineral known. (5) Deformation temperature is low (870°C) which brings it close to that of a glass or enamel. (*Sodium Series.*)

(1) The members toward the high Na_2O corner have a stony or slaglike appearance and are not glossy like those toward the high SiO_2 end. (2) Two deformation eutectics are found on the straight line Na_2O-SiO_2. (*a*) 51.5% Na_2O, 48.5% SiO_2 (830°C); (*b*) 18.4% Na_2O, 81.6% SiO_2 (860°C). (3) A ternary deformation eutectic was found of the composition: 17.55% Na_2O, 5.33% Al_2O_3, 77.12% SiO_2. (4) The deformation temperature of this eutectic is 800°C and approaches that of a glass or enamel. It is close to that of K_2O–Al_2O_3–SiO_2 eutectic which was 870°C. (5) This eutectic has a lower alumina content than any natural sodium aluminum-silicate mineral known. (6) The composition of the ternary eutectic is practically the same in percentage composition by weight as that of the K_2O–Al_2O_3–SiO_2 system. Consequently Na_2O and K_2O may be said to have the same fluxing value pound for pound when introduced in the form of carbonates.

Rice, B. A.

BIBLIOGRAPHY OF ENAMEL TESTS AND METHODS OF CONTROL. *Bull. Amer. Ceram. Soc.*, **5,** 238 (1926). Appendix C of Enamel Division Report. See also Poste, E. P. (this *Bibliography*, p. 237).

***Rice, B. A.**

ZIRCONIA IN ENAMELS. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 41).

EFFECT OF DEGREE OF SMELTING UPON PROPERTIES OF FRIT. See E. P. Poste (this *Bibliography*, p. 248).

Rice, George L., and Gilchrist, Benjamin W.

ENAMELING METALLIC ARTICLES. U. S. Pat. 971,641, Oct. 4, 1909.—A coating containing a magnetic material and sulphur is deposited upon the article electrolytically and the enamel is applied to this. The metallic article is immersed in an electrolyte consisting of sulphur and a salt of a magnetic metal. (*Chem. Abs.*, **5,** 31 (1911); *Chem. and Ind.*, **30,** 87 (1911).)

Richard

LEAD-FREE GLAZES. *Bull. d'enc.*, p. 558 (1867); *Wieck's Gwz.*, p. 352 (1868); *Pr. Mech. J. 3. S*, **4,** 200. (*Rep. der Tech. Lit.*, p. 306 (1854–1868).)

ENAMELING OF METAL. *Publ. ind.*, **32,** 186. (*Rep. der Tech. Lit.*, p. 118 (1888–1890).)

Richards, E.

MELTING CAST IRON IN ELECTRIC FURNACE. *Stahl u. Eisen*, **46,** 249 (1926).—Electric furnace cast iron has much better mechanical properties, is denser, and has a finer-grained fracture than cupola iron, and the foundry is independent of the coke supply. But as the electric process is expensive, the "Duplex" process, in which the cupola is used in conjunction with a basic-lined electric furnace, is recommended. Oxygen is removed by both the manganese and the carbon; calcium carbide is formed near the electrodes, and sulphur is removed by the combined action of calcium oxide, carbon, and calcium carbide. (*Ceram. Abs.*, **5,** 243 (1926); *Chem. and Ind.*, **45B,** 324 (1926).)

Richardson

USE OF BORATE OF CALCIUM IN GLAZES. *Lond. J. N. S.*, **3,** 338. (*Rep. der Tech. Lit.*, p. 306 (1854–1868).)

Rickmann, R.

WHITE COVERING FOR ENAMELS. French Pat. 451,238, Dec. 2, 1912; British Pat. 27,954, Dec. 4, 1912.—Antimony is heated to redness with saltpeter and an alkaline

hydroxide, and the product, consisting of a mixture of antimonates with antimony oxide, is washed and ground. (*Chem. Abs.*, **7**, 3210 (1913); *ibid.*, **8**, 1861 (1914); *Chem. and Ind.*, **32**, 604, 1012 (1913).)

Rickmann, R.

WHITE PIGMENTS FOR ENAMELS, ETC. German Pat. 283,204, Dec. 5, 1911.—Substances containing antimony are used. Refer to *Chem. Abs.*, **8**, 1861 (1914). (*Chem. Abs.*, **9**, 2444 (1915).)

Rickmann, R.

ANTIMONY COMPOUNDS FOR PRODUCTION OF WHITE ENAMEL. *Sprechsaal*, **45**, 115 (1912); *La Céramique*, **15**, 134 (1912).—Antimony oxide should be avoided, but the antimonates are not injurious to health. Workmen handling $NaSbO_3$ during ten years were not affected injuriously. The antimony oxide compounds (tartar emetic) are poisonous. The use of antimony oxide for enamels for cooking vessels is to be avoided. $NaSbO_3$ is not decomposed by acetic or fruit acids. Enamels produced with $NaSbO_3$ did not give off any metallic compounds to AcOH. After the destruction of the enamel, the $NaSbO_3$ was dissolved in part undecomposed, and in a harmless condition. The $NaSbO_3$ is, hence, well suited for the production of white enamel. (*Chem. Abs.*, **6**, 1348, 2679 (1912); *Chem. and Ind.*, **31**, 231 (1912).)

Rickmann, R.

MANUFACTURE OF WHITE OR LIGHT-COLORED ENAMELS. U. S. Pat. 716,106, Dec. 16, 1902.—Sodium antimonate is fused with the enamel; 7 to 10% is added for a good and durable white enamel. (*Chem. and Ind.*, **22**, 94 (1903).)

Rickmann, R.

WHITE OPAQUE ENAMELS. U. S. Pat. 1,203,409, Oct. 31, 1916.—Enamels such as may be formed of feldspar, SiO_2, borax, and soda are rendered more acid resisting and given whiteness and opacity by the addition of a small proportion of $KSbO_3$ which is produced for the purpose in insoluble form by the reaction $5Sb_2O_3 + 2KOH + 6KNO_3 = 8KSbO_3 + Sb_2O_4 + H_2O + 6NO$. (*Chem. Abs.*, **11**, 93 (1917); *Chem and Ind.*, **35**, 1262 (1916).)

Rickmann, R.

TESTING OF ENAMELS CONTAINING ANTIMONY. *Z. angew. Chem.*, **25**, 1518 (1912).—The sample is boiled for half an hour with 4% acetic acid or 2% tartaric acid. The antimony in solution is titrated with permanganate. The meta-antimonates are not attacked by this treatment. (*Chem. and Ind.*, **31**, 775 (1912).)

Rickmann and Rappe

MANUFACTURE OF AN OPAQUE ENAMEL. German Pat. 203,773, June 30, 1907.—It has been proposed to use the fluoride or silico-fluoride of cerium for the production of opaque enamels, but during the melting process the effect of these compounds is partially destroyed; indeed on prolonged heating, the enamel mass dissolves them with production of a clear glaze. According to the present patent, this defect is overcome by replacing the compounds mentioned by cerium oxide or such cerium compounds, *e. g.*, the carbonate, which yield the oxide, or by a mixture of oxides of cerium metals, such as is obtained as a by-product in the manufacture of thorium nitrate. (*Chem. Abs.*, **3**, 699 (1909); *Chem. and Ind.*, **28**, 92 (1909).)

Riddle, F. H.

TYPES OF ENAMEL USED FOR ENAMELING CAST-IRON SANITARY WARE. *Trans. Amer. Ceram. Soc.*, **9**, 646 (1907).—Fundamental requirements for enamel: (1) to fuse

at proper temperature, just below 1000°C; (2) to mature quickly and lie smoothly; (3) to withstand sudden changes of temperature and fit the iron perfectly; (4) to have a perfectly smooth vitreous surface; (5) to be insoluble or difficultly soluble in water and weak acids; (6) to present a pleasing appearance to the eye. Starting enamel:

$$\left.\begin{array}{l}0.4285\ PbO\\0.2142\ BaO\\0.1071\ CaF_2\\0.1428\ Na_2O\\0.1071\ K_2O\end{array}\right\}\ 0.1071\ Al_2O_3\ \left\{\begin{array}{l}0.9186\ SiO_2\\0.2857\ B_2O_3\\0.15\ SnO_2\end{array}\right.$$

O. R. 1:1.66

Range of favorable composition: *Alkalis:* 0.2 to 0.6 equivalent, excess is soluble in water; should be kept near the lower limit; should be introduced as feldspar in order to bring in combined alumina and silica; enough should be added as nitrate to prevent reduction; it is best to introduce B_2O_3 as borax, therefore this must be considered. *Fluorides:* 0.083 to 0.125 equivalent: lower than 0.083 would make the glasses less easily fused: satisfactory at 0.125 and could probably go to 0.3. *Barium:* 0 to 0.45 equivalent; substitute for lead to some extent; ratio of BaO and PbO to other RO ingredients ought to be about 1:0.5 to 1:0.7. *Boracic acid:* 0.05 to 0.3 equivalent; introduced as borax or boracic acid, preferably as borax if it does not make the sodium content too high; strong acid flux. *Lead oxide:* 0.1 to 0.4 equivalent; high amounts produce transparency and yellow enamels. *Zinc oxide:* 0.0 to 0.1 equivalent; acts as an opacifier; rather infusible; tends to overcome yellow cast produced by lead. *Alumina:* 1 to 0.25 equivalent; avoid the use of clay; the higher Al_2O_3 is the less tin will have to be used. *Silica:* 0.75 to 1.25 equivalent; introduced as flint, feldspar, or clay; should be kept as high as possible; prevents crazing; excess causes shivering and raises the melting point. *Tin oxide:* 0.2 to 0.25 equivalent; 0.15 equivalent gives about 7.5% and works well. (*Chem. Abs.*, **2**, 1483 (1908); *Chem. and Ind.*, **27**, 565 (1908).)

Rieke, R.

REDDISH DISCOLORATION OF OPAQUE TIN OXIDE GLAZES. *Ber. deut. keram. Ges.*, **5**, 2 (1924).—The research laboratory of the State Porcelain Works, Berlin, traced the discoloration to a small amount of chrome salts present in the red lead oxide, the characteristic bright red color of which had been preserved by the addition of organic coloring matter. The quantity present was too small to be revealed by analysis and on investigation it was found that as low as 0.0025% chrome oxide led to a decided discoloration. On this account lead oxide should be closely watched for traces of chrome. Tests also showed that the discoloration developed under oxidizing conditions and disappeared if the glaze was subjected to a reducing atmosphere. (*Ceram. Abs.*, **4**, 25 (1925).)

Rielkötter, K.

MAKING OF WELDED ENAMEL GOODS. *Stahl u. Eisen*, **29**, 1273 (1909).

Ries, H.

STATUS OF SAND TESTS. I. *Foundry*, **53**, 531 (1925).—The usual tests applied to sand are discussed and the importance of standardization of tests pointed out. Sieve tests are more rapid than elutriation tests. After separation into groups of grain size the best manner of expressing the results is important. Four plotting methods are shown. (*Ceram. Abs.*, **4**, 332 (1925).)

Riesser, Simon

PRODUCING A SINGLE WHITE ENAMEL COAT ON STEEL. U. S. Pat. 1,360,317, Nov. 30, 1920.—In the treatment of frit in the production of white enamel on steel, the process of grinding the frit with water and clay and removing a portion only of the soluble enam-

eling constituents. (*Jour. Amer. Ceram. Soc.* (Abs.), **4,** 255 (1921); *Chem. Abs.*, **15,** 583 (1921); *Chem. and Ind.*, **40A,** 47 (1919).)

Riesser, S.

WHITE ENAMELED STEEL VESSEL. U. S. Pat. 1,360,318, Nov. 30, 1920.—As an article of manufacture, an unmottled white enameled steel vessel or surface provided with a single white enamel coat placed directly upon the steel.

Rietz, E.

GLASS, ENAMELS, AND GLAZES. British Pat. 148,816, July 10, 1920.—Relates to the manufacture of white clouded glass, enamels, and glazes. Fluorides are used in conjunction with compounds of Zr, Sn, Be, etc. Alkali fluorides, alkali silico-fluorides, CaF_2, and cryolite are stated to be suitable compounds for use. A frit given as an example consists of Na_2CO_3, feldspar, quartz, natural zirconia, and sodium silico-fluorides. The fluorine compounds are used in larger proportions than has hitherto been done. The batches must contain a large proportion of SiO_2. (*Jour. Amer. Ceram. Soc.* (Abs.), **4,** 250 (1921); *Chem. Abs.*, **15,** 299 (1921).)

Rietz, Eduard

PROCESS FOR MANUFACTURE OF WHITE CLOUDED GLASSES, ENAMELS, AND GLAZES. U. S. Pat. 1,366,101, Jan. 18, 1921.—The process which comprises the embodying unpurified clouding material in the glass, glaze, or enamel with material containing sufficient fluorine to prevent discoloring. (*Jour. Amer. Ceram. Soc.* (Abs.), **4,** 253 (1921); *Chem. Abs.*, **15,** 934 (1921); *Chem. and Ind.*, **40A,** 180 (1921).)

Roadhouse, R.

FURNACE FOR ENAMELING CERAMIC OR OTHER WARE. U. S. Pat. 1,395,732, Nov. 1, 1921.—The furnace is adapted to be heated by oil burners. (*Ceram. Abs.*, **1,** 131 (1922); *Chem. and Ind.*, **40A,** 892 (1921).)

Roberts, F. G.

OPERATING MUFFLE FURNACES. U. S. Pat. 1,472,401, October 30, 1923.—Muffles such as those used in firing enamelware are kept continuously up to working temperature by simultaneously heating both the interior and exterior of the muffle. (*Ceram. Abs.* **3,** 96 (1924); *Chem. Abs.*, **18,** 453 (1924).)

***Roberts and Mander Stove Co.**

ENAMELING PLANT USES NEW TYPE DUST COLLECTION SYSTEM. See *Ceram. Ind.* (this *Bibliography*, p. 52).

Robinson

MANUFACTURE OF ENAMELED DIALS AND OTHER PLATES. Specification No. 1356 (1874). (*Rep. der Tech. Lit.*, p. 38 (1874).)

Robinson

NEW PROCESS OF ENAMELING. *Dt. Amerik. Gwz.*, p. 177 (1875). (*Rep. der Tech. Lit.*, p. 47 (1875).)

Robiquet

PREPARATION OF ENAMEL. *Dingl. p. J.*, **28,** 452. (*Rep. der Tech. Lit.*, p. 272 (1823–1853).)

Robson, J. T.

INVESTIGATION ON PICKLING. *Enamelist*, **1** [8], 10 (1924).—(1) A rise in temperature of the pickling acid diminishes the time required.

Room temp., 78°F	1.00 (time taken as unity)
100	0.47
125	.14
150	.07
175	.04
200	.01

At 175°F irritating acid fumes are given off. (2) Air agitation increased the time of pickling at 78°F. But at 100°F there was a saving of 25% of the time, at 125°F and 150°F there was a saving of about 20% of the time. At 175°F air agitation had no effect. (3) Effect of cleaning.

Method	Time to pickle in 10% sulphuric acid at 78°F (minutes)
Annealed at 1300°F	36
Annealed at 1600°F	81
Boiling sodium hydroxide solution	32
Boiling trisodium phosphate solution	32

Robson, J. T.

USE OF HYDROCHLORIC ACID FOR PICKLING. *Enamelist*, **3** [1], 14 (1925).—Results: Average results of three different samples in each test. Temperature of annealing 1400°F.

Per cent	Time Required to Pickle at Temperatures				
HCl by weight	77°F	105°F	120°F	150°F	180°F
1	38	13	10	7	3
2	23	8	4	2′–20″	2
3	13	7	3	1′–50″	1
4	9	5	2′–45″	1′–50″	1
5	8	4	2′–30″	1′–30″	1
6	6	3	2	1′–20″	45″
7	5	2′–30″	1′–30″	1′–10″	45″
8	4	2′–30″	1′–30″	1′–10″	30″
9	3	2′	1′–20″	1	30″
10	2	1′–30″	1	1	30″
11	2	1′–10″	1	50″	25″
12	2	1′–10″	1	45″	25″
13	1′–50″	1′–5″	1	30″	25″
14	1′–50″	1	1	30″	25″
15	1′–40″	1	50″	30″	25″
20	1′–25″	1	40″	30″	20″
25	5	1′–30″	1′–10″	35″	15″
30	7	2	1′–30″	40″	15″
35	9	7	3′–30″	1′–30″	15″

In general the best concentration of hydrochloric acid for rapid pickling lies between 10 and 20% and for convenience in working 105°F appears to be the most practical temperature. A 12% hydrochloric acid solution at 105°F appears to be about the best. Except at 180°F the time of pickling using hydrochloric acid is much less than when using sulphuric acid. Agitation in the solution had little or no effect. Average loss in weight in 10% hydrochloric at room temperature was 1.2% as against 2.1% loss in weight in sulphuric and at room temperature.

Robson, J. T.

USE OF SULPHURIC ACID FOR PICKLING. *Enamelist*, **2** [9], 15 (1925).—Temperature of annealing: 1400°F

Strength of sulphuric acid, per cent by wt.	Time Required to Pickle at Temperatures				
	77°F (minutes)	105°F (minutes)	120°F (minutes)	150°F (minutes)	180°F
1	80	24	14	8	2½ min.
2	45	15	8	4½	1½ min.
3	40	15	5	4	1½ min.
4	35	14	6	3	1¼ min.
5	30	13	4	3½	1¼ min.
6	28	12	5	3	1¼ min.
7	25	11	4	3	1¼ min.
8	22	12	4	2½	1¼ min.
9	20	12	4	2½	1¼ min.
10	20	11	5	2½	1¼ min.
11	20	11	5	2	1 min.
12	20	9	5	2	1 min.
13	18	8	5	2	55 sec.
14	16	8	4	2	45 sec.
15	15	8	4	1½	45 sec.
20	9	7	5	1½	30 sec.
25	8	6	4	1½	25 sec.
30	12	7	4	1½	20 sec.
40	13	6	5½	2	1 min.
50	30	18	17	25	8 min.

The best temperature for the most rapid and practical pickling appears to lie between 120 and 150°F. Below 120°F the time of pickling is greatly increased and at 180°F the fumes are excessive. The best, most practical, and most economical concentration appears to be 5% sulphuric acid from 120 to 150°F.

Robson, J. T.

USE OF A MIXED SULPHURIC HYDROCHLORIC ACID FOR PICKLING. *Enamelist*, **3** [Nov.], 5 (1925).—The average of four different samples in each test follows.

Temperature of annealing: 1400°F

Strength of acid 2 parts H_2SO_4 to 1 part HCl	Time Required to Pickle at Temperatures				
	77°F	105°F	120°F	150°F	180°F
3	30	8	6	2′–30″	2
6	16	7	5	2	1′–30″
9	15	5	2′–30″	1′–30″	50″
12	9	3′–30″	1′–30″	1	40″
18	8	2	1	50″	30″
24	5	1	50″	25″	20″
30	2′–30″	50″	45″	20″	15″

The best conditions for rapid and satisfactory pickling with a mixed acid of 2 parts sulphuric and 1 part of hydrochloric acid appears to be from 12 to 18% concentration at 120 to 150°F. The average loss in weight of the steel pickled in 12% mixed acid at room temperature was about 2%. Agitation had little or no effect on the time of pickling.

Robson, J. T.

COMPARATIVE CRAZING AND CHIPPING OF WET AND DRY PROCESS CAST-IRON ENAMELS. *Jour. Amer. Ceram. Soc.*, **7**, 563 (1924).—Heat-shock tests are run on commercial samples of cast-iron stove parts enameled by both the wet and dry process. These enamels applied by the wet process are much more resistant to temperature change

than those enamels applied by the dry process. Composition of the enamels is not given. The test pieces were heated in an electric furnace and then immediately plunged into water at a temperature of 76°F. The temperature was noted for each piece where crazing or chipping was first noticed. Impact tests were made by placing test pieces of the different samples in a ball mill and rotating for 5 minutes. Tests were also made by striking the pieces with a hammer. The enamels applied by the wet process are probably more resistant to impact than those applied by the dry process. (*Chem. Abs.*, **18,** 3263 (1924); *Chem. and Ind.*, **45B,** 675 (1924).)

Roenelt, T. J.

REMOVING ENAMEL. Austrian Pat. 7,713, Sept. 12, 1911.—The articles are heated to redness while being acted upon by KCN, whereby the enamel can be readily scaled off or, after cooling in water, dissolved away, leaving a clean metallic surface. (*Chem. Abs.*, **7,** 3649 (1913).)

Roenelt, T. J.

PROCESS OF ENAMEL STRIPPING BY HEATING WITH ALKALINE COMPOUNDS. French Pat. 434,301, Sept. 16, 1911.—Potassium cyanide is sprinkled on the enamel heated to just redness. The enamel may be lifted off after half a minute, or the object placed in water which will dissolve the alkalis, and thus loosen the enamel. (*Chem. and Ind.*, **31,** 336 (1912).)

Roenelt, T. J.

REMOVING ENAMEL. German Pat. 240,926, Aug. 13, 1910.—Removing enamel from jewelry, etc., by heating the articles to a red heat, covering with 99% KCN and heating a short time therewith. The enamel can then be removed readily, or it may be dissolved by water. (*Chem. Abs.*, **6,** 2156 (1912).)

***Roesch Enamel Range Co.**

METAL RACKS ECONOMICAL. See *Ceram. Ind.* (this *Bibliography*, p. 60).

Rohland, P.

CAUSES OF PLASTICITY AND ALLIED PROPERTIES OF CLAY AND KAOLIN. *Silikat Ztg.*, **2,** 30.—R. criticizes Brown and Montgomery in their work on dehydration of clays, for inferring that there may be some relation between chemically combined water and plasticity and maintains, as usual, that clays owe this property to colloidal material alone. He disputes their argument that organic material cannot be considered as a cause of plasticity, because it would be burned out at 500° and some clays are still plastic after being subjected to that treatment; he calls attention to the fact that colloidal material may be of two kinds, organic and inorganic, and that even though the organic be destroyed, the inorganic still remains, which shows that carbonaceous or organic material may contribute to the cause of plasticity. (*Chem. Abs.*, **8,** 3845 (1914).)

Rohland, P.

MEANS OF ALTERING THE AMOUNT OF PLASTICITY OF CLAYS. *Sprechsaal*, **42,** 1371.—The plasticity of clays is increased by contact with spring or river water, decrease in temperature, and addition of colloids. The first change is brought about by the production of colloids by hydrolysis. Thus silicic acid, aluminum, and iron hydroxides are formed. This action is expedited by fine grinding. The hydroxyl ions produced by the hydrolysis tend to decrease plasticity, hence pure water is not suitable for the above purpose. Spring or river water, on the other hand, neutralize the action of the hydroxyl ions, owing to the acid fermentation of the organic constituents present, assisted by the organic matter of the clay or substance added intentionally. Bacterial processes also

are of importance in this connection. The second means of increasing plasticity, lowering of the temperature, is also connected with the colloids of clay. The volume of softened clay is smaller than its original volume plus the volume of water imbibed. Contraction and evolution of heat hence take place. Applying the principle of Maupertuis, the plasticity must increase by lowering the temperature. The reaction is a very slow one. The third means of increasing the plasticity is the addition of colloids, and organic substances like dextrin, tannic acid, catechu, etc. Plasticity is decreased by the addition of hydroxyl ions and raising the temperature. For this purpose lime-water is the cheapest reagent. If for some clays the concentration of the hydroxyl ions of lime-water is not sufficient the action may be increased by an addition of sodium hydroxide solution, or all strong bases combined with weak acids. The latter class is represented by phosphates, silicates, etc. Neutral salts like sodium chloride, glaubers' salt, magnesium chloride, etc., appear to be indifferent. The effect of hydroxyl ions is weakened, compensated, or strengthened by the addition of anions or cations. Thus borax weakens the effect of the hydroxyl ions and potassium carbonate strengthens the action. Just as gelatin, agar-agar, etc., liquefy on heating to a certain temperature, so increased temperature causes clay to "run" and decreases plasticity. It appears likely that the organic constituents of clay bring about this liquefication as soon as a certain limiting temperature has been exceeded. The increase in temperature may be brought about mechanically by stirring. There is, up to a certain point, coincidence of plasticity with bonding power. (*Chem. Abs.*, **1**, 90 (1907).)

Rohland, P.

PLASTICITY OF CLAY. *Z. anorg. Chem.*, **31**, 158.

Rosenow, M.

PLASTICITY OF CLAY. *Tonind.-Ztg.*, **35**, 1261 (1911).—The product of tensile strength expansion and water content (the "plasticity number") was found to be constant for any given clay. To eliminate experimental errors it was determined at several water contents. Clays arranged according to the plasticity number took the same rank as when arranged according to plasticity found in practice. Experiments on hygroscopicity, heat of wetting, and size of grain point to an enormously increased surface for plastic clays. This is commonly explained by the "colloidal envelop" but R. contends that the idea of a porous ultimate structure is sufficient. A real explanation of plasticity is still lacking. (*Chem. Abs.*, **6**, 143 (1912).)

Rosenzweig, C.

WHITE ENAMEL FOR GLAZED GOODS. U. S. Pat. 995,724, June 20, 1911.—A glazing mass and a silicate of Zr, Th, Gl, La, or Yt, which is freed from coloring admixtures and is white at the temperature at which it is caused to glow. (*Chem. Abs.*, **5**, 2711 (1911); *Chem. and Ind.*, **30**, 896 (1911).)

***Rosenzweig**

WHITE ENAMEL. See Landau and Co. (this *Bibliography*, p. 188).

WHITE ENAMEL OF GREAT COVERING POWER. See Landau and Co. (this *Bibliography*, p. 189).

***Ross, D. W.**

FLOW OF CLAY UNDER PRESSURE. See Bleininger, A. V. (this *Bibliography*, p. 27).

Rupprecht, George

MAKING ENAMELS. U. S. Pat. 1,360,585, Nov. 30, 1920.—The process consists in subjecting the raw materials to the direct action of a flame developing a high tempera-

ture under conditions which prevent the material melted from coming in contact with foreign substances and supporting the molten material upon an unmolten mass of the raw materials. (*Jour. Amer. Ceram. Soc.* (Abs.), **4,** 255 (1921); *Chem. Abs.*, **15,** 583 (1921); *Chem. and Ind.*, **40A,** 47 (1921).)

Sachse, H.

PRODUCTION OF WHITE OPAQUE GLAZES, ENAMELS, AND GLASSES. German Pat. 331,682, July 20, 1918; British Pat. 148,816, July 10, 1920.—White opaque glasses, enamels, and glazes are made by means of natural compounds of zirconium, tin, and beryllium in combination with fluorine compounds, such as alkali fluorides of fluosilicates, fluorspar, and either natural or artificial cryolite, in sufficient quantity to prevent the production of color by the impurities in the other ingredients. The large proportion of fluorine compounds ensures good covering power, ready fusibility, high gloss, and great resistance to chemicals and heat. (*Chem. and Ind.*, **40A,** 348, 736 (1921).)

Saglio, M.

ENAMELS OF HIGH DILATATION FOR CAST OR COMMON IRON ON THE BASIS OF "PANDERMITE." *Bull. de la Soc. d'Encouragement,* **3,** 1060 (1898).—A series of experiments was carried out with the object of utilizing "pandermite" as a substitute for borax in the preparation of enamels of high dilatation for coating metals. "Pandermite" is a natural calcium borate of the following composition: anhydrous boric acid, 55.73; lime, 37.07; magnesia, 0.45; sulphuric acid, 2.55; carbonic acid, traces; alumina and oxide of iron, 0.10; insoluble matter, 0.38; and water and organic matter, 3.63; total, 99.91. Mixtures of "pandermite" with feldspar, in proportions varying from 30 to 70%, all gave promising results, but especially so the mixture of 40 parts of "pandermite" to 60 parts of feldspar. This mixture fuses below 800°C without loss of boric acid, forming a homogeneous frit suitable for enamels and ceramic work. It is of average hardness and easily pulverizable. Fluorspar and pandermite, mixed in proportions of 60 parts of the former to 40 of the latter, yielded a very fluid frit, fusing below 800°C without loss of boric acid or fluorine, and capable of increasing the dilatation of enamels. Fifty parts of this frit, 5 rutile, 30 sand, 8.6 sodium carbonate, and 10 cryolite, yielded an enamel of high dilatation, fusing at 1050°C and only slightly attacked by acids. It would therefore appear to be suitable in all respects for application to iron. Ninety parts of this mixture used as a frit, with 10 parts of petalite, produced an enamel of high dilatation (1.07 g., measured by the Le Chatelier method) of sufficient fluidity, and fusing below 830°C. This, therefore, would also seem to be suitable for iron, and might possibly prove useful as a hygienic enamel for hardware. Mixtures of cryolite with fluorspar and a little rutile yield enamels of very high dilatation and sufficient fusibility, which may be recommended generally as suitable to metals of high dilatation. Of simple mixtures, pandermite, sodium carbonate, and sand yield an enamel of which the dilatation is 894, and which might be found useful for cast and sheet iron. An enamel composed of 80 parts of petalite to 20 of pandermite, of which the dilatation is 483, though somewhat expensive, owing to the large proportion of petalite used in it, is suitable for application to certain porcelains and stoneware of low dilatation. Enamels of lower dilatation may be produced without having recourse to either cryolite or rutile by means of sand, sodium carbonate, pandermite, and other substances. The experiments taken as a whole show that by the use of boric acid, it is quite possible to produce hygienic calcareous enamels, free from lead, and suitable for application to iron, as well as others of varied dilatation and fusibility, some of which are but very slightly attacked by acids. It would also appear that natural calcium borate provides an excellent economical substitute for sodium borate, at present almost exclusively used

in the enamel and ceramic industries. The lime introduced is not all prejudicial to the quality of the enamels. (*Chem. and Ind.*, **17**, 924 (1898).)

Salt

ENAMEL FOR METAL TUBES, IRON VESSELS, ETC. *Mech. M. N. S.*, **3**, 121. (*Rep. der Tech. Lit.*, p. 306 (1854–1868).)

ENAMEL ON IRON PLATES, SIGNS. *Mech. M. N. S.*, **7**, 209. (*Rep. der Tech. Lit.*, p. 306 (1854–1868).)

Salt, J.

EMPLOYMENT OF BOROCALCITE FOR ENAMELS. *Monit. Ceram.*, **31**, 97.—Besides boric anhydrides, of which borocalcite contains 47%, it also contains certain other constituents: viz., lime, water of hydration, carbon dioxide, sodium carbonate, silica, and alumina, which are useful in enamels, while, according to S., the small proportions of sulphuric acid, and iron oxide, as well as the magnesia and insoluble matters, are without any injurious action. A successful transparent, white enamel for fine faience can be prepared from a frit containing powdered borax, 3340 parts; Fontainebleau sand, 1600; calcium carbonate, 1600; feldspar, 2460; and kaolin, 1000 parts (loss on fusing, 21.30%) of which material, 63.50 parts are mixed with: feldspar, 1400; silica, 1000; and lead carbonate, 1250 parts. Equally good results can be obtained at lower cost by substituting borocalcite for the borax, as follows: frit: borocalcite, 1850 parts; Fontainebleau sand, 2050; calcium carbonate, 1350; feldspar, 3150; kaolin, 1600 parts (loss on fusion, 6.65%). Enamel: frit, 6350 parts; feldspar, 1400; silica, 1000; lead carbonate, 1050 parts. The modified enamel does not crack or scale, the coefficient of expansion being the same as that of the original type. (*Chem. and Ind.*, **19**, 1112 (1900).)

Sample, W. L.

NOTES ON FELDSPAR TESTS. *Bull. Amer. Ceram. Soc.*, **5**, 477 (1926).—Methods of making fusion tests of feldspars are briefly discussed, with particular stress on the shape of the test piece and the bond used. (*Ceram. Abs.*, **6**, 68 (1927).)

Sanborn, P. H.

SLIP MAKING AND CONTROL. *Jour. Amer. Ceram. Soc.*, **8**, 555 (1925).—(1) Slips of high viscosity will cast very rapidly, but if used for solid pieces, the portion next to the mold will shrink away from the mold, leaving an excess of water in the center. This causes a piece of varying density which may crack in the drier. Slips of low viscosity require more time but give more uniform ware. (2) First additions of a 1:1 mixture of sodium carbonate and sodium silicate cause a rapid drop in viscosity after which the effect becomes less. Further additions cause a more gradual rise. It is possible, therefore, to obtain the same viscosity with two different additions of electrolytes, but the properties are quite different. (3) Heavy slips will require an excessive amount of electrolyte. Light slips delay the time of casting and are difficult to keep in suspension. The proper weight of slip can only be determined by experiment. (4) Viscosity is greatly affected by temperature changes. The speed of flow of the water through the body is a function of the temperature. The proper temperature can be determined by experiment. (5) One factor will cause variations in the other. The best method seems to be that of holding as many as possible at a constant value. If weight and temperature can thus be held constant the viscosity can be adjusted with some degree of certainty by means of electrolytes. Discussions by E. T. Montgomery, C. C. Treischel, H. Goodwin, K. M. Smith, F. S. Hunt, E. H. Fritz, W. K. McAfee, L. Navis, C. B. Youmans, E. Schramm, and A. L. Donnenwirth. (*Chem. Abs.*, **19**, 3151 (1925).)

Sandby, R.

PROCESS FOR PERMANENTLY PRODUCING PICTURE EFFECTS UPON ENAMELED METAL SURFACES. U. S. Pat. 1,335,755, April 6, 1920.—After the enameled surface to be treated is cleaned, it is coated with a uniform coat of a suitable gum varnish. After the varnish has set the picture is transferred upon it. This is done by first printing the matter to be transferred on transfer paper with printers' ink, dusting it evenly with a mixture of metallic oxide and silica, and pressing the inked and coated paper upon the varnished surface. The paper is then removed and after the coated surface has dried it is dusted with a low-fusing flux. The whole is then fired. (*Jour. Amer. Ceram. Soc.* (Abs.), **3,** 600 (1920); *Chem. Abs.*, **14,** 1745 (1920).)

Sato, S.

A_3 AND A_4 TRANSFORMATION OF IRON. *Sci. Rept. Tohôku,* **14,** 513 (1925).—In pure iron, during heating, the A_4 transformation is accompanied by an expansion and the A_3 by a contraction. These changes are reversed in cooling, the ratio of magnitudes of change in length being $A_4:A_3::10:3$. (*Ceram. Abs.*, **5,** 243 (1926); *Chem. and Ind.*, **45B,** 324 (1926).)

Sauer, J.

IMPORTANCE OF ELECTRIC WELDING IN PLATE AND ENAMELWARE INDUSTRY. *Glashütte,* **41,** 996, 1020, 1042, 1064 (1911).—Article contains nineteen illustrations which are explained. (*Chem. Abs.*, **6,** 672 (1912).)

Sauerwald, F., and Wecker, J.

CHANGE IN VOLUME OF PIG IRON ON MELTING. *Z. anorg. Chem.*, **149,** 273 (1925); *Chem. and Ind.*, **45B,** 131 (1926).—Gray pig iron contracts when it melts, white pig iron expands. The contraction is probably due to formation of carbide in the fused mass. (*Ceram. Abs.*, **5,** 143 (1926).)

Sauveur, A.

DIFFERENTIATION OF IRON AND STEEL. *Rev. Met.*, **22,** 355 (1925).—Iron and steel are sharply marked by their respective carbon and manganese contents. Commercial iron is defined as the element iron as pure as it may be obtained commercially. Ingot iron is commercial iron produced in a liquid state and cooled. Forged iron is a malleable ferrous metal, produced from a plastic condition. (*Ceram. Abs.*, **5,** 12 (1926); *Chem. and Ind.*, **44B,** 635 (1925).)

Sauveur, A.

"ARMCO" IRON. *Rev. Met.*, **22,** 397 (1925).—Brief outline of the process of manufacture and properties. (*Ceram. Abs.*, **5,** 14 (1926).)

Saxe, C. W.

DEVELOPMENTS IN HEAT TRANSFERRING REFRACTORIES. *Enamelist,* **2** [8], 7 (1925).—First heat resistants or refractories were products made of fireclay grog and fireclay. Later silicon carbide and bonded fused alumina were considered. Silicon carbide helped by prolonging the life of the furnace, etc., but was affected by oxygen in the furnace. The refractory answering the requirements is bonded, crystalline, fused alumina. This is already an oxide and is not subject to change at industrial temperatures.

Schaefer, J.

USE OF ZINC SULPHIDE IN WHITE AND LUMINOUS ENAMELS. *Keram. Rundschau,* **25,** 75 (1917); *Jour. Soc. Glass Tech.*(Abs.), **2,** 50 (1918).—In sheet-steel enamels of

suitable composition zinc sulphide is an excellent opacifier in the absence of metallic oxides which tend to decompose it. The opacity is equal to that produced by stannic oxide, but the enamels are not so white or brilliant. The opacity effect is due to the zinc sulphide itself. Zinc sulphide cannot be used in colored enamels or with oxides of lead, arsenic, antimony, or manganese. Luminous zinc sulphide may be incorporated without losing its luminosity and the enamels retain their power for years with only very slight loss in luminosity. (*Chem. Abs.*, **12,** 2677 (1918); *Chem. and Ind.*, **37A,** 584 (1918).)

Schaefer, J.

NEW IDEAS IN THE ENAMELING INDUSTRY. *Stahl u. Eisen*, **38,** 257 (1918).—The enameling of sheet iron is discussed from the standpoint of the chemist and progress in the art is outlined. (*Chem. Abs.*, **13,** 2986 (1919).)

Schaefer, J.

USE OF ZINC SULPHIDE FOR WHITE AND LUMINOUS ENAMELS. Taschenbuch fur Keramiker, *Keram. Rundschau*, 29 pp. (1919).—Owing to the high cost of SnO_2 as an opacifier for enamel, substitutes for this are important. The use of zinc sulphide (German Pat. 289,317) has attracted considerable attention because it is comparatively cheap. A series of experiments were run to determine if zinc sulphide or zinc oxide produced opacity in enamels. A very fusible enamel was used containing about 5% cryolite and the enamel was fired at 800°C. In Expt. I 5% ZnS and 6% clay were added to the mill. An opaque glaze was obtained with a yellowish tinge probably due to the Fe in the sulphide. In Expt. II 4.1% ZnO and 6% clay were added. This enamel did not cover well showing that ZnS and not ZnO is necessary to produce opacity. Another series of experiments showed that ZnS is not destroyed in less fusible glazes unless certain metals which have a strong affinity for Zn are present. The more refractory enamels containing ZnS, however, are not as glossy as the same containing SnO_2. A number of patents have been granted for making luminous enamels with luminous ZnS since the chemical composition is not very different from that of pure ZnS. Luminous ZnS (*i.e.*, radioactive ZnS) has been used for some time with transparent varnish for various instruments. The disadvantage of using varnish as a binder is that the radioactivity of the paint has only a short life, being practically gone at the end of 3 years whereas luminous enamels would probably last 10 years. It is necessary that 40 to 50% luminous ZnS be added to an enamel to produce sufficient luminosity in the dark and for this purpose a very fusible enamel seems best suited. Enamels containing ZnS cannot be used to make colored enamels since the coloring oxide would combine with the ZnS producing poor colors. (*Jour. Amer. Ceram. Soc.* (Abs.), **4,** 75 (1921); *Chem. Abs.*, **15,** 426 (1921).)

Schaefer, J.

ENAMEL AND ITS USE IN THE CHEMICAL INDUSTRY. *Z. angew. Chem.*, **28,** 419 (1915).—History of the industry and a general description of enamels and enameling methods. (*Chem. Abs.*, **10,** 260 (1916).)

Schauer, Th.

OBSERVATIONS TO BE NOTED IN COOLING OF ENAMELS. *Sprechsaal*, **60,** 238 (1927).—The following conclusions are given which will lead to the improvement of enamels: the amount of crystallization of the enamels should be reduced to a minimum; control of time and temperature of annealing corresponding to the enamel used permit the greatest development of cast pearlite, uniform cooling in such a manner as to eliminate large temperature differences between enamel and iron. (*Ceram. Abs.*, **6,** 568 (1927); *Chem. Abs.*, **21,** 4039 (1927).)

Schlemmer, J.

COMMON PRACTICE OF ENAMELING CAST IRON. *Giesserei Ztg.*, **7,** 237 (1910).

Schlemmer, J.

PRINCIPAL CONSTITUENTS OF ENAMEL GLAZE. *Giesserei Ztg.*, **7,** 334 (1910).

Schmick, Hans

TEMPERATURE DISTRIBUTION IN FREE REFLECTING GLOWING IRON BLOCKS. *Z. tech. Physik*, **6,** 365 (1925).—The temperature distribution in cylindrical iron blocks has been calculated for the first minutes after the beginning of cooling and for an initial temperature of 1200°. The temperature of the surface so ascertained is connected with the mean temperature of the block. The difference between these temperatures is considerable with blocks of large diameter, since the cooling progresses only very slowly toward the interior of the block. The experiments reported on iron rods of 3-cm. diameter are of the order of magnitude of those calculated. (*Ceram. Abs.*, **5,** 14 (1926).)

***Schmidt**

PRODUCTION OF TRANSPARENT AND OPAQUE ENAMELS ON WROUGHT IRON (SHEET IRON) BY MEANS OF LAYERS OF FINE GOLD OR SILVER FOIL. See Fix (this *Bibliography*, p. 120).

Schmidt, Charles R.

METHOD OF ENAMELING. U. S. Pat. 862,285, Aug. 6, 1907; also British Pat. 19,429, Aug. 29, 1907.—This method of enameling hollow cylindrical articles on their inner and outer surfaces simultaneously, consists in heating the articles and placing enameling material inside them, then rotating them in a horizontal position in a rotating enameling chamber or muffle, and as each part of the external surface is brought uppermost, depositing enameling material upon it. (*Chem. and Ind.*, **26,** 1009 (1907).)

Schnurpfeil's Rev. Glass Works, **2,** 137 (1916).

BLACK ENAMELS. Five formulas are given without discussion. (*Chem. Abs.*, **10,** 2133 (1916).)

Schnurpfeil's Rev. Glass Works, **3,** 549.

COMPOSITION OF ENAMELS FOR CAST IRON

	White	White	Blue	Blue
Feldspar	40	42	46	25
Borax	28	22	21	30
Soda ash	10	13	14	11
Saltpeter	1		2	3
Fluorspar		5	4	
Cobalt oxide			1.75	2
Quartz				17
Cryolite				3
Tin oxide	8	8		2

(*Jour. Amer. Ceram. Soc.* (Abs.), **3,** 600 (1920).)

Schnurpfeil's Rev. for Glass Works, **4,** 613.

COMPOSITION OF BLUE ENAMEL FOR CAST IRON

Feldspar	34	Fluorspar	5½
Borax	21	Saltpeter	2
Soda ash	13	Cobalt oxide	1½

(*Jour. Amer. Ceram. Soc.* (Abs.), **3,** 772 (1920).)

Schnurpfeil's Rev. for Glass Works, **4** [41], 647 (1920).

COMPOSITION OF WHITE CAST-IRON ENAMELS

	No. 1	No. 2
Borax	22.0	19.0
Feldspar	46.0	32.0
Sodium carbonate	12.0	6.5
Saltpeter	.75	2.5
Tin oxide	15.5	8.5
Fluorspar	1.0	3.0
Cryolite		1.5
Zinc oxide		2.5
Bone ash		2.0

(*Jour. Amer. Ceram. Soc.* (Abs.), **3**, 935 (1920).)

Schoop, M. U.

DEVICE FOR COATING ARTICLES WITH GLASS, ENAMEL, QUARTZ, OR METALS. U. S. Pat. 1,617,166, Feb. 8, 1927.—The coating material is applied by use of a blow pipe projection device. (*Ceram. Abs.*, **6**, 169 (1927); *Chem. and Ind.*, **46B**, 221 (1927).)

Schory, V. S.

MAGNESIA AS AN OPACIFIER. *Jour. Amer. Ceram. Soc.*, **2**, 477 (1919).—Glazes used:

No. 1	No. 2	No. 3		
0.30	0.30	0.30 K_2O	0.50 Al_2O_3	4.00 SiO_2
0.20	0.30	0.40 CaO		
0.20	0.10	0.00 ZnO		
0.30	0.30	0.30 MgO		

No. 4	No. 5	No. 6		
0.25	0.25	0.25 K_2O	0.40 Al_2O_3	3.30 SiO_2
0.25	0.35	0.45 CaO		
0.20	0.10	0.00 ZnO		
0.30	0.30	0.30 MgO		

No. 7		
0.30 K_2O	0.50 Al_2O_3	4.00 SiO_2
0.70 CaO		

From the data it appears that glazes Nos. 1 to 6, when fired to form opaque, glossy coats, are really in the condition of overfired porcelains and may be more accurately designated as glossy, vitreous slips. It was found also that zinc and barium did not increase transparency of the coats except as they increased the fusibility. (*Chem. Abs.*, **13**, 2266 (1919); *Chem. and Ind.*, **38A**, 635 (1919).)

Schott, E. A.

FURNACES FOR ENAMELING INDUSTRY. *Giesserei Ztg.*, **6**, 103 (1909).

Schott, E. A.

MUFFLE FURNACES FOR ENAMELING AND OTHER INDUSTRIAL PURPOSES. *Giesserei Ztg.*, **6**, 171–95 (1909).

Schott, E. A.

ENAMELING-MUFFLE FURNACES WITH DIRECT FIRING. *Giesserei Ztg.*, **6**, 675–737 (1909).

Schott, E. A.

MUFFLE OVEN FOR ENAMEL WORKS AND OTHER INDUSTRIAL PURPOSES. *Stahl u. Eisen*, **31**, 310 (1911). (*Chem. Abs.*, **5**, 2315 (1911).)

***Schramm, Edward**

DEFLOCCULATION OF CLAY SLIPS AND RELATED PROPERTIES. See Scripture, E. W. (this *Bibliography*, p. 274).

Schramm, Edward, and Scripture, E. W., Jr.

PARTICLE SIZE DISTRIBUTION OF TYPICAL FELDSPARS AND FLINT. *Jour. Amer. Ceram. Soc.*, **10**, 264 (1927).—The results of particle size analyses of a number of commercial feldspars and flints by the sedimentation method are reported. A comparison of batch and continuous grinding is given as well as a study of the progress of ball-mill grinding. (*Ceram. Abs.*, **6**, 228 (1927); *Chem. Abs.*, **21**, 1874 (1927); *Chem. and Ind.*, **46B**, 678 (1927).)

Schröder, E.

MUFFLE KILN FOR ENAMELS. German Pat. 296,457, Oct. 31, 1915.—In order to effect a more uniform distribution of the heat, a muffle kiln for enamels is provided with a deep, narrow circumferential flue extending beneath it. The sole of the kiln is built with two or more steps, and part of the kiln wall is constructed of a material (*e.g.*, Carborundum) of lower thermal conductivity than fire clay. By this means, the flames play on each support for only a short time and the heat is not as severe as usual. Even if a support is built of poor materials and cracks, it cannot choke the flue. Further advantages are that the flue dust does not attack the walls of the kiln so readily and the muffles last longer. The sole of the muffle may be built of arch brick and a better distribution of heat secured. (*Chem. and Ind.*, **36**, 596 (1917).)

Schröder, E.

ENAMELING PROCESS. German Pat. 397,241, Nov. 4, 1920.—The enamel flux is mixed with a liquid fuel and forced through spraying devices by compressed gas. By the combustion of the fuel, the enamel is deposited on the surface of the article as a molten spray. The enamel flux may be formed by mixing the anhydrous raw materials with suspended colloids in suitable proportions in the burning flame. The process effects considerable economy in fuel. (*Chem. and Ind.*, **43B**, 789 (1924).)

Schröder, E.

ENAMELING PROCESS. German Pat. 401,808; addition to German Pat. 397,241, Nov. 12, 1920.—The metallic oxides in the paste that is sprayed on to the metal are replaced wholly or partly by metallic powders, *e.g.*, aluminium or a mixture of aluminium and magnesium which act as fuel in the spray. (*Chem. and Ind.*, **43B**, 789 (1924); **44B**, 72(1925).)

Schuler, A. J.

PROCESS FOR DULLING ENAMELS. Canadian Pat. 146,740, Mar. 18, 1913.—A siliceous material is mixed with the covering mass and fired in a furnace on the article to be enameled. (*Chem. Abs.*, **7**, 1792 (1913).)

Schuler, A. J.

PROCESS FOR DULLING ENAMELS. British Pat. 28,679, Dec. 12, 1912.—Metal or other articles are provided with a dull enamel coating by first firing the article with an enamel coating of ordinary composition, and afterward firing with a second enamel coating which is prepared by intimately mixing together ordinary enamel ingredients comprising about equal quantities of alkali and SiO_2, fusing the ingredients to form a vitreous mass, grinding this mass and mixing therewith a quantity of raw siliceous materials nearly equal to the quantity of the ordinary enamel ingredients. A suitable

composition for the first coating of enamel, consists of 15 kg. of borax, 12 kg. of feldspar, 9 kg. of SiO_2, 3 kg. of fluorspar, 6 kg. of raw cryolite, 6 kg. of purified soda powder, 1.5 kg. of white alumina, 100 g. of MnO_2, and 50 g. of Co. The second coating is formed by adding to the first coating composition 2 kg. of SnO_2 and a quantity of $(NH_4)_2CO_3$, and, after grinding, intimately mixing, fusing, and regrinding the materials; a paste consisting of 100 g. of raw kaolin and 700 g. of raw feldspar made into a paste with 1 to 1.5 kg. of water is added for each kilogram of the mixture. Surfaces for receiving writing may be made by adding suitable quantities of magnesium carbonate, soda or borax to the second coating. (*Chem. Abs.*, **8,** 1861 (1914); *Chem. and Ind.*, **33,** 81 (1914).)

Schuler, A. J.

MAT ENAMELING. French Pat. 450,458, Nov. 12, 1912.—Silicic acid compounds, such as quartz, feldspar, kaolin, are added to the mass for the purpose of reducing the alkalinity. The metal articles to be enameled are placed in the furnace but once. The composition is borax 15 kg., feldspar 12 kg., quartz 9 kg., fluorspar 3 kg., unfused cryolite 6 kg., soda 6 kg., white clay 1.5 kg., epidote 100 g., cobalt 50 g. (*Chem. Abs.*, **7,** 3210 (1913).)

Schuler, A. J.

MAT FINISHED ENAMEL SURFACES. German Pat. 261,114, Mar. 5, 1912.—The metal body to be coated is dipped in the coating mass, which is composed of silicic acid, containing earths, natural silicates, and various salts, with the addition of quartz, feldspar, or kaolin to reduce the alkalinity, and then the articles are fired. For the preparation of colored or white writing tablets, magnesium carbonate, soda, borax, etc., are added to the coating mass. (*Chem. Abs.*, **7,** 3211 (1913).)

Schuler, A. J.

ROUGHENING OF ENAMELS. *Céramique*, **16,** 239 (1913).—To roughen enamels, S. mixes quartz, feldspar, or kaolin with a cover compound of earths, or silicates, and salts before application to the object. The addition of SiO_2 reduces the alkali content. To render white, black, or colored surfaces applicable to inscriptions of crayons, graphite, or chalk in addition to the above, $MgCO_3$, Na_2CO_3, or $Na_2B_4O_7$ is added to the cover compound. (*Chem. Abs.*, **8,** 224 (1914).)

Schulz, F.

IMPORTANCE OF FLUORINE COMPOUNDS IN ENAMELS. *Chem. Ztg.*, **48,** 711 (1924).—When the supply of Greenland cryolite was largely cut off during the war, Na_2SiF_6 was the chief substitute, the importance of fluorine was recognized. A test made with and without F and B showed the strong opacifying effect of F. Another very important function of F is a strengthening of the coloring power of the coloring oxides, particularly the weaker ones. (*Chem. Abs.*, **19,** 713 (1925).) See also Esch, W. (this *Bibliography*, p. 114).

Schulz, H.

LUSTER AND ITS MEASUREMENT. *Textilber*, **5,** 25 (1924).—The Goerz "glanzmesser" compares the normal and diffuse reflection of light from a standard source. Polarization luster-measuring devices require adjustment to the refractive index of the material examined. The device may be used on artificial silk, paper, etc. (*Ceram. Abs.*, **3,** 189 (1924).)

Schulz, Walter

CONDUCT OF METAL OXIDES IN GROUND-COAT ENAMEL. *Ceram. Ind.*, **4, 371** (1925).—Translation of article by Louis Vielhaber, in *Keram. Rundschau*. See this *Bibliography*, p. 320.

Schulz, Walter

HOW SODIUM AND FLUORINE AFFECT ENAMEL FUSION. *Ceram. Ind.*, **5,** 346 (1925).—The influence of the opacifiers, fluorspar, cryolite, and sodium silico-fluoride, on the fusing points of enamels were studied. The following commercial batches of enamel, without addition of zinc oxide and clay, were made up:

	I (%)	II (%)	III (%)
Quartz	19.1	20.3	12.0
Boric acid	4.3		
Borax	34.4	38.8	34.9
Feldspar	34.6	28.2	28.9
Aluminum oxide	3.2		2.6
Fluorspar	3.5		
Soda ash		10.2	5.3
Cryolite		2.2	
Niter cake			13.2
Sodium silico-fluoride			3.0

The effect of varying the fluorspar, at the expense of the other ingredients, from 3.5 to 72% was studied, using Batch I. The results show that fluorspar is considered a flux up to 4%, a nonflux from 4 to 25%, and a flux from 25 to 50%. At higher percentages it approaches its own fusion point. Calcium and silica mixtures gave similar results. A second series, in which the quartz content of Batch I was increased and the feldspar reduced approximately $66^2/_3$%, was subjected to a variation in fluorspar content. Fluorspar acted as a flux up to 5%, as a nonflux 5 to not over 18%, and as a flux up to 45%. A third trial was made, using Batch II, increasing the content of cryolite from 2.2 to 62%. Up to 20% cryolite acted as a strong flux and lowered the fusion point of the enamel from 950 to 820° C. A fourth trial was made, using Batch III, in which the sodium silico-fluoride was increased. There was a gradual increase in fusion points, with increase in sodium silico-fluoride. (*Ceram. Abs.*, **5,** 10 (1926).)

Schurecht, H. G.

USE OF ELECTROLYTES IN THE PURIFICATION AND PREPARATION OF CLAYS. Bur. Mines, *Tech. Paper*, No. 281 (1922).—To maintain maximum dispersion the alkalis should be added in terms of clay weight rather than in terms of H_2O weight. To prevent the plasticity of treated kaolin from exceeding that of the original kaolin add slightly less than an equivalent amount of H_2SO_4 in neutralizing the alkalis in sedimentation. A deflocculating agent like H_2SO_4 will prevent kaolin from passing through the filter press. Dry strength is increased by the electrolytes, NaOH showing the greatest effect. Many precautions and suggestions are given. (*Chem. Abs.*, **16,** 1643 (1922).)

Schuss

PROTECTIVE TREATMENT OF IRON-BLAST FURNACE TUYÈRES. German Pat. 319,938, May 31, 1918 (Gebr., Dampfkessel-und Apparate-Bauan-stalt).—The castings are coated with a highly refractory enamel. Any liquid iron falling upon this surface flows off readily. (*Jour. Amer. Ceram. Soc.* (Abs.), **4,** 317 (1921).)

Schüz, E.

SHRINKAGE OF CAST IRON. *Stahl u. Eisen*, **45,** 1189 (1925).—White-heart cast iron contracted 1.93% and black-heart cast iron 1.89%. Thin-walled castings shrank somewhat more, and thick-walled castings somewhat less. The white heart had the greater carbon content. The effect of silicon up to 3.3% is negligible on the shrinkage of pearlite and hyperpearlite cast iron. In annealing, shrinkage is less the more temper carbon the castings contain, and greater the more the casting is decarburized. It may

be artificially influenced by long or short annealing according to wall thickness. Annealed thin-walled white heart shrank 2%, thick-walled white heart and thin-walled black heart 1.5%, and thick-walled black heart 1%. (*Ceram. Abs.*, **5,** 11 (1926); *Chem. and Ind.*, **44B,** 673 (1925).)

Schwarzbach

HINT FROM ENAMEL TECHNOLOGY. *Diamant*, **37,** 525 (1915).—To secure uniform and complete fusion the addition of borax, magnesium oxide, or ammonium chloride is recommended. (*Chem. Abs.*, **10,** 960 (1916).)

Schwier, Carl

PIECE WORK IN STOVE PRODUCTION. *Enamelist*, **1** [4], 9 (1924).—Article describes how different steps of the enameling process has been put on a piece-work basis. The average cost of firing ground coat and white was set at 60 cents per 100 sq. ft. divided between the burners and helpers in the same ratio as their day rate. Deductions are made due to misapplication and ware scratched at the furnace. The pickling rate is 38 cents per 100 sq. ft. This includes all work connected with pickling. The spraying rates are: 17 cents per 100 sq. ft.; 25 cents per 100 sq. ft. for ware sprayed on both sides; and 25 cents per 100 pounds for cast iron. Maximum cost of dipping and loading in drier is 55 cents per 100 sq. ft. Sandblasting and rimming edges are still on a day-rate basis.

Schwier, Carl

ELECTRIC FURNACE FOR VITREOUS ENAMELING. *Jour Amer. Ceram Soc.*, **6,** 1030 (1923).—An electric furnace for vitreous enameling built with round wire coils placed in top, bottom, and both sides. The furnace is equipped with a double loading fork. Some cost data are given. Discussions by B. T. Sweely, H. H. Clark, L. W. Manion, F. G. Jaeger, F. S. Roberts, R. E. Arnold, R. D. Wells, J. A. Hain, W. R. Greer, Mr. Freeman, H. F. Staley, R. Roadhouse, L. D. Bridge, and R. A. Weaver. (*Chem. Abs.*, **17,** 3911 (1923); *Chem. and Ind.*, **42A,** 1223 (1923).)

Sc. Am., **6,** 106.

ENAMELING OF IRON. (*Rep. der Tech. Lit.*, p. 306 (1854–1868).)

Sc. Am., **20,** 154.

IMPROVEMENTS IN ENAMELING IRONWARE. (*Rep. der Tech. Lit.*, p. 405 (1869–1873).)

Sc. Am. Suppl., **33,** 1342.

HOW ENAMELED LETTERS ARE MADE. (*Rep. der Tech. Lit.*, p. 185 (1891–1893).)

Scott, G. M.

ENAMELS. British Pat. 241,018, Oct. 22, 1924.—An enamel for squeezing through a stencil of silk used in the manufacture of signs is made by mixing frit or quartzlike material and coloring matter to a damp powder with both mineral and vegetable oils and then working the powder to a pasty consistency with the aid of a mineral grease or jelly. (*Chem. Abs.*, **20,** 2569 (1926).)

Scott, H. H., and Scott, G. M.

VITREOUS ENAMEL METAL SIGNS. U. S. Pat. 1,516,065, Nov. 18, 1924.—A method of producing vitreous enamel metal signs and other decorative articles, comprising applying a vitreous enamel composition through a mesh and onto a vitreous enamel surface, and heating the product to an enamel fusing temperature. (*Chem. Abs.*, **19,** 386 (1925).)

Scott, H. H., and Scott, G. M.

VITREOUS ENAMEL METAL SIGNS. U. S. Pat. (reissue) 16,048, April 21, 1925.—See original U. S. Pat. 1,516,065 and British Pat. 198,837. Method of producing designs upon a vitreous surface which comprises taking a pasty vitrifiable enamel composition containing finely-ground vitrifiable enamel and an oily carrier and capable of being applied to a surface in subdivided form by being pressed through a fine mesh and of retaining a subdivided form upon the surface until heated, placing a fine-mesh stencil onto the vitreous surface and forcing the composition through the mesh portion of the stencil onto the vitreous surface, whereby the composition will be applied to the design portion of the surface in subdivided form, and finally heating the article to an enamel-fusing temperature. (*Chem. Abs.*, **19**, 1763 (1925).)

Scripture, E. W., Jr.

BEHAVIOR OF FELDSPAR AND FLINT WITH ACIDS AND BASES. *Jour. Amer. Ceram. Soc.*, **10**, 238 (1927).—On addition of acids and bases to fine ground feldspar or flint, the same phenomena are observed as with clays, *i.e.*, flocculation, deflocculation, and absorption. The effects are less sharp than with clays, the zone of deflocculation covering a wide range of p_H and flocculation occurring at lower p_H (greater acidity). The sensitiveness of flint and feldspar to reagents increases with fineness of grinding. (*Ceram. Abs.*, **6**, 228 (1927); *Chem. Abs.*, **21**, 1874 (1927); *Chem. and Ind.*, **46B**, 441 (1927).)

***Scripture, E. W., Jr.**

PARTICLE SIZE DISTRIBUTION OF TYPICAL FELDSPARS AND FLINTS. See Schramm, Edward (this *Bibliography*, p. 270).

Scripture, E. W., Jr., and Schramm, Edward

DEFLOCCULATION OF CLAY SLIPS AND RELATED PROPERTIES. *Jour. Amer. Ceram. Soc.*, **9**, 175 (1926).—In an earlier paper the authors have given the particle analysis and other tests of a number of English china clays, one English ball clay, and several domestic kaolins. In this paper are presented the following additional data for the same clays: the carbon content as a measure of organic matter; the change in state of dispersion with p_H for 20% slips as determined by settling tests; the change in viscosity with p_H as determined with 40% slips; the alkali absorption for 20 and 40% slips. The more plastic clays are characterized by high organic content, high alkali absorption, and dispersion at low p_H. Casting slips made up with different china clays and two ball clays in varying proportions show that ball clay causes fluidity and that the plastic china clays produce more viscous slips than the less plastic.

Seaber, W. M.

VISCOSITY AND ITS ESTIMATION. *Ind. Chemist*, **2**, 243 (1926).—Measurement of viscosity is of the greatest importance in (1) adhesive, (2) soaps, (3) molten glass, (4) petroleum. The "poise," the scientific unit of viscosity, is the unit force required to overcome the "drag." This is difficult to measure directly, hence the rate of flow through an orifice (intimately connected with the viscosity) is the method employed in common instruments. The absolute viscosity is shown by the formula $(\pi g\, d\, h\, r^4\, t/8\, V\, l)$, where d is the density of the liquid; h, its head; r, the radius of the orifice; l, the length of the orifice; and t, the time for volume V to flow out (all quantities in c. g. s. units). In most commercial instruments the hole is short and large corrections must be applied in calculating the absolute viscosity. The Redwood, Saybolt Universal, and Engler instruments are described and discussed. Simple and convenient methods of determining relative viscosities are given. A table of conversion factors for, and the

effect of temperature on, the three instruments mentioned above are given. Standardization of instruments and viscosity values as a guide in blending oils are discussed. (*Ceram. Abs.*, **5**, 331 (1926).)

Sealey, P. T., and Greene, G. W.

MODEL PLANT FOR FLEXIBLE PRODUCTION. *Ceram. Ind.*, **9**, 1421 (1927).—A description of the plant of the Leonard Refrigerator Co. is given. (Illustrated.) (*Ceram. Abs.*, **6**, 428 (1927).)

Sederholm, P.

ANOMALIES IN HEAT CONDUCTION IN STEEL. See Benedicks, C. (this *Bibliography*, p. 17).

Seelig, Albert F. H.

ENAMELING FURNACE. U. S. Pat. 1,515,368, Nov. 11, 1924.—In a furnace of the kind described, the combination of a heating chamber, a muffle supported therein, and means for directing the hot gases in a plurality of passes and in opposite directions under and in direct contact with the bottom of the muffle. (*Ceram. Abs.*, **4**, 5 (1925).)

Sellards, E. H.

CLAYS OF FLORIDA. *Jour. Amer. Ceram. Soc.*, **1**, 313 (1918).—A few results of 25 tests on common clays of Florida are given. I. The possible uses of the clays given are as follows: (1) Jackson County clay may be used in the manufacture of common and building brick. (2) Washington County clay may be used in the manufacture of buff-colored brick, although care must be exercised in drying. (3) Santa Rosa County clay is of value only in the manufacture of porous common building brick, etc. (4) Escambia County clay is suitable for common and face brick, etc., but not for paving brick or other vitrified ware. (5) Walton County clay is suitable for the manufacture of porous common and building brick. Not practical to vitrify in commercial kilns. (6) It is doubtful whether a vitrified product may be manufactured from Duval County clay, owing to the relatively high temperatures necessary. (7) Clay County clay is a plastic red-firing clay having a high drying shrinkage. Care must be exercised in drying heavy pieces. This clay has a relatively low porosity at commercial kiln temperatures and attains a fairly dense structure. (8) Jefferson County clay may have some use in the manufacture of soft porous common building brick. (9) Polk County clay may have some use in the manufacture of soft porous common building brick. II. Plastic Kaolins. (1) *Occurrence:* This clay is being worked at Edgar in Putnam County and Okahumpka in Lake County. (2) *Mining:* The clay is lifted chiefly by suction pumps carried on a floating dredge. From the relaying pumping station on the dredge, it passes through the washing station (coarse sand and clay balls being removed) to settling tanks. It is then pumped from these tanks to compressors to remove the excess of moisture. The clay is further artificially dried for shipment. All of the plastic kaolin produced in Florida is shipped out of the state.

***Seyfert, F.**

ESTIMATING FUSIBILITY OF ENAMELS AND SILICATES. See Kochs, E. (this *Bibliography*, p. 175).

Shaw, J. B.

CONTROL OF COMPOSITION OF FELDSPAR. *Ceram. Ind.*, **2**, 91 (1924).—Uniformity of composition is sought in order to maintain certain standards of quality. The time required for chemical analysis makes it impossible to control the product by this method. Rapid methods have been devised for the determination of free quartz. The quartz

content may then be controlled by blending. The presence of black mica is harmful in that it causes black specks. By subjecting feldspar to a moderate heat treatment, rapidly cooling the feldspar thus heated and then subjecting it to moderate grinding, four very desirable results are obtained: (1) The mica is reduced to such a state that it can be entirely eliminated. (2) The quartz, being affected similarly to the mica, a considerable proportion of it will be eliminated with the mica. (3) The treatment renders the feldspar so easily pulverized that the capacity of the pulverizing plant is about trebled. (4) The feldspar is bleached so that a pure white product results.

Shaw, J. B.

PREPARATION OF GLAZES AND ENAMELS. *N. J. Ceramist,* **1,** 52 (1921).—Red specks are developed in lead glazes by particles of organic matter such as wood fiber from linings of ball mills or particles of woody matter from ball clay. The weighing of (large) glaze batches is a useless refinement unless the moisture content of the material is regularly determined and taken into consideration. (The alternative method must be assumed to be proportioning by volume.[1]) The tempering of glazes should be done during the grinding, and care should be used to proportion the water, plastic clay, and tempering agent so as to prevent settling of the heavier constituents. Five pounds of ball clay when properly tempered with a suitable flocculating agent is as effective in floating heavy glaze ingredients as 10 lbs. of clay without such flocculating agent. S. is opposed to the practice of preparing large batches of glazes and storing because of the settling of the ingredients and the probability of inadequate stirring before drawing off for use. The importance of thoroughness in the mixing of the ingredients for frits is emphasized. Failure to observe this precaution may occasion a serious loss in the opacity of enamels containing tin oxide or antimony oxide. This applies in some degree to cryolite and other fluorides. One of the essentials in the successful use of antimony oxide in enamels is care in mixing it most thoroughly with the other ingredients before fritting. Little success was attained until it was ground into a ball mill with part of the feldspar of the batch. During the charging of the frit kiln, there is an appreciable loss of fine dustlike material which is sucked up the stack by the draft. This may be avoided by closing the stack damper before charging or wetting the charge before introducing it into the furnace. The charge should be spread evenly in the furnace and stirred frequently. This prevents segregation and increases speed of fusion. S. has noted the development of specks in white enamels fritted in furnaces using fuel oil. He attributes these to particles of carbon from the fuel oil reducing lead in the frit. (*Jour. Amer. Ceram. Soc.* (Abs.), **4,** 788 (1921); *Chem. Abs.*, **15,** 2975 (1921).)

Shaw, J. B.

ANTIMONY OXIDE AS AN OPACIFIER IN CAST-IRON ENAMELS. *Jour. Amer. Ceram. Soc.*, **1,** 502 (1918).—In order to produce antimony enamels of satisfactory color the following should be emphasized: (1) Use only the purest, white, antimony oxide. (2) Use a little fluorspar (not over 5% of the raw batch). (3) Be sure to maintain oxidizing conditions during smelting (use plenty of niter). (4) Control the color by the addition of ferric oxide, manganese dioxide, and lead oxide. (5) Cryolite is unsatisfactory as a flux or opacifier in antimony enamels but small quantities (up to 3%) will aid in producing a good color and without introducing any troublesome element. (6) Extreme care in proportioning the raw materials, very careful and thorough mixing, and proper smelting will ensure the successful use of antimony oxide. Discussion by E. P. Poste and H. F. Staley. (*Chem. Abs.*, **13,** 253 (1919); *Chem. and Ind.*, **38A,** 107 (1919).)

[1] Abstractor's note.

Shaw, J. B.

FISHSCALING. *Jour. Amer. Ceram. Soc.*, **3**, 489 (1920).—The results obtained in the laboratory would lead to the conclusion that the chemical composition of the enamel has very little bearing on the subject of fishscaling. When laboratory results (where no fishscaling is obtained) are considered in the light of factory results, where all of the formulas show fishscaling, the above conclusion would seem to be greatly strengthened. If it is established that the chemical composition has little bearing on the cause and control of fishscaling, that in itself represents a long step toward the solution of the problem. If the chemical composition of the enamel is eliminated, other sources for the trouble exist: (1) composition of the steel is frequently blamed; (2) cleaning and preparation of the steel; (3) mechanical manipulation in applying the enamel; (4) fritting and preparation of the enamel; (5) firing the enamel. While all of these have been given by different manufacturers as contributory causes, none of them as far as is known, have been seriously studied in a systematic manner, with a view to proving the contention. Treischel produced evidence which seemed to show pretty conclusively that the strength of the acid in the pickling batch has a positive influence on blistering, but fishscaling is a defect distinctly different from blistering. It may be that the two defects are very similar insofar as their cause is concerned. In this series of experiments, the laboratory trials were all pickled in a strong hydrochloric acid solution (10%) while those made in the factory were pickled in dilute sulphuric acid. There is not sufficient evidence here on which to base any conclusions of value but what there is

BATCH WEIGHTS OF GROUND COATS USED

No.	Feldspar	Flint	Borax	Soda	Niter	Fluor-spar	Lead oxide	CoO	MnO_2
1	84	54	76.4	30	8.5	16	0	2.5	8.7
2	84	54	152.8	8.5	8.5	16	0	2.5	8.7
3	84	54	76.4	30	8.5	0	44.6	2.5	8.7
4	84	54	152.8	8.5	8.5	0	44.6	2.5	8.7
5	84	6	76.4	30	8.5	16	0	2.5	8.7
6	84	6	152.8	8.5	8.5	16	0	2.5	8.7
7	84	6	76.4	30	8.5	0	44.6	2.5	8.7
8	84	6	152.8	8.5	8.5	0	44.6	2.5	8.7
9	168	0	76.4	13.8	8.5	16	0	2.5	8.7
10	168	0	152.8	0	8.5	16	0	2.5	8.7
11	168	0	76.4	13.8	8.5	0	44.6	2.5	8.7
12	168	0	152.8	0	8.5	0	44.6	2.5	8.7
		Clay							
13	84	38.7	76.4	30	8.5	16	0	2.5	8.7
14	84	38.7	152.8	8.5	8.5	16	0	2.5	8.7
15	84	38.7	76.4	30	8.5	0	44.6	2.5	8.7
16	84	38.7	152.8	8.5	8.5	0	44.6	2.5	8.7
		Flint							
17	84	34	76.4	30	8.5	16	44.6	2.5	8.7
18	84	34	152.8	8.5	8.5	16	44.6	2.5	8.7
19	84	6	76.4	30	8.5	16	44.6	2.5	8.7
20	84	6	152.8	8.5	8.5	16	44.6	2.5	8.7
21	168	0	76.4	13.8	8.5	16	44.6	2.5	8.7
22	168	0	152.8	0	8.5	16	44.6	2.5	8.7
		Clay							
23	84	38.7	76.4	30	8.5	16	44.6	2.5	8.7
24	84	38.7	152.8	8.5	8.5	16	44.6	2.5	8.7

1A, 2A, etc. = 10% flint added to 1, 2, etc.
1B, 2B, etc. = 20% flint added to 1, 2, etc.
1C, 2C, etc. = 10% calcined kaolin added to 1, 2, etc.
1D, 2D, etc. = 20% calcined kaolin added to 1, 2, etc.

would indicate that pickling had little bearing on the subject. Poor steel is a favorite excuse for many enamelers and assigning a reason for fishscaling. It ought not to be very difficult to prove whether this is true or not. In this series of experiments, three grades of steel were used: (1) Bessemer, (2) open hearth, and (3) American ingot iron. The data show that formula 12, one of the three which developed fishscaling in the laboratory, shows the defect on all three kinds of steel. Here, again, what little data were obtained would seem to indicate that the grade of the steel has little bearing on the subject. One fact that is universally recognized is that fishscaling is much more common on heavy gage (20 to 16) than on light gage (28 to 20) steel. This was recognized throughout the experiments, both in the laboratory and the factory. This fact, with all it signifies, must be considered in the solution of the problem. Preparation, application, and firing of the enamel are all fields capable of containing the main cause of the defect. One point in this connection was touched upon in these experiments. The enamels made in the laboratory were all ground dry, giving enamels with a much smaller percentage of fine material than is obtained in wet grinding. It is possible that further investigation of this point would show this to be one of the chief reasons for the difference in results obtained in the laboratory and factory, and reveal one of the chief causes of fishscaling. Coarse grinding is quite universally recognized to give best results in ground coats. All the data here obtained are negative in character; still it is believed that not a great amount of additional data of this kind would be required to point to the proper solution of this problem. Fishscaling will be found to be due not to one single cause, but to a combination of contributory causes. The fishscale seems likely to be a small chip of enamel forced off the steel by the expansion of gas under it. The gas bubbles are always present, whether fishscaling occurs or not; but when the other conditions are properly combined, fishscaling occurs. Twenty-four frits were used with 5 different mill additions, thus making 120 enamels. (*Chem. and Ind.*, **39A,** 599 (1920); *Chem. Abs.*, **14,** 2689 (1920).)

Shaw, J. B.

ALLOWABLE LIMIT OF VARIATION IN INGREDIENTS OF ENAMELS FOR SHEET STEEL. *Trans. Amer. Ceram. Soc.*, **11,** 103 (1909).—Investigation confined largely to the ground coat. Good commercial enamel should have the following properties: (1) must fit the steel (show no crazing or shivering); (2) relation between the heat treatment required by the ground coat and the subsequent coats must be such that it will form a good bond between the enamel without the undercoat boiling or fusing sufficiently to cause defects in the outer coat; (3) must resist the action of dilute acetic acid; (4) must contain no lead; (5) finished ware must be pleasing to the eye; and (6) enamel must be cheap. Article gives series of batches with their results. *Conclusions for ground coats:* (1) The oxide of sodium and potassium are interchangeable, increase in potassium oxide increases the brilliance. (2) Replacement of potassium oxide with calcium oxide hardens the enamel; limits of CaO 0.14 to 0.64 equivalents. (3) CoO increases stability in firing. Not absolutely necessary but desirable. (4) Al_2O_3: increase of alumina oxide increases brilliance and adhesiveness up to 0.5 equivalent; increases refractoriness; increases viscosity; limits 0.1 to 0.5 equivalent. (5) SiO_2: high SiO_2 causes shivering; low SiO_2 causes crazing; SiO_2 hardens the enamel; lower limit 1.1 equivalent. (6) B_2O_3: high B_2O_3 causes shivering; low B_2O_3 produces mat enamels; stronger than SiO_2 in producing shivering; stronger in affecting brilliance than SiO_2. Limits 0.2 to 0.5 equivalent: (7) CaF_2 vs. $CaCO_3$: substitution of calcium carbonate for calcium fluoride produces no change in quality but hardens raw enamel some. (8) Cryolite vs. feldspar: substitution of cryolite for feldspar softens enamel markedly and produces opacity; high cryolite and low feldspar cause crazing; high feldspar and low cryolite

cause shivering; best results are obtained using equal amounts of the two. Particular limits applied only to formula used. *Conclusions for cover enamels:* (1) Good white enamel is easy to produce if on a good, hard ground coat. (2) K_2O *vs.* Na_2O: interchangeable; K_2O gives brighter glass. (3) CaO: affects refractoriness; should not be below 0.2 equivalent. (4) Al_2O_3: increases opacity, brilliancy, and makes them harder; 0.0 to 0.4 equivalent gives good results. (5) SiO_2: increases hardness and insures safety against acids; limits 1.0 to 1.8 equivalent. (6) B_2O_3: softens enamel; increases luster; lower limit 0.2 equivalent. SnO_2 *vs.* ZnO plus Sb_2O_3: tin oxide may be replaced by zinc oxide plus antimony oxide; 0.13 equivalent of tin oxide or zinc oxide plus antimony oxide produces good white opacity using two coats of white. Conclusions in formula form:

Ground coat

$$\left.\begin{matrix} K_2O & 0.15\text{–}0.75 \\ Na_2O & 0.0\text{–}0.6 \\ CaO & 0.14\text{–}0.64 \\ CoO & 0.0\text{–}0.06 \end{matrix}\right\} Al_2O_3 \quad 0.1\text{–}0.5 \left\{\begin{matrix} SiO_2 & 1.1\text{–}1.7 \\ B_2O_3 & 0.2\text{–}0.5 \end{matrix}\right.$$

Cover coat

$$\left.\begin{matrix} K_2O & 0.0\text{–}0.60 \\ Na_2O & 0.0\text{–}0.65 \\ CaO & 0.2\text{–}0.60 \end{matrix}\right\} Al_2O_3 \quad 0.0\text{–}0.5 \left\{\begin{matrix} SiO_2 & 1.0\text{–}1.8 \\ B_2O_3 & 0.2\text{–}? \end{matrix}\right.$$

(*Chem. Abs.*, **3,** 2740 (1909); *Chem. and Ind.*, **28,** 1130 (1909).)

Shaw, J. B.

TESTING SHEET-STEEL ENAMELS. *Trans. Amer. Ceram. Soc.*, **12,** 463 (1910).—Conditions of use of enamelware requires consideration on: (1) chemical tests, (2) sudden changes of temperature, and (3) impact test.

Formula used

$$\left.\begin{matrix} 0.4 & Na_2O \\ 0.2 & K_2O \\ 0.4 & CaO \end{matrix}\right\} X\ Al_2O_3 = \left\{\begin{matrix} Y\ SiO_2 \\ Z\ B_2O_3 \end{matrix}\right.$$

X, Y, and Z were varied

Test pieces were 20-gage steel $1^1/_2$ x 3 in. given ground coat then white cover coat. *Acid tests:* A sample of each enamel was boiled for 15 minutes in a 1% solution of sulphuric acid. Another sample of each enamel was boiled for 20 minutes in a 75% solution of acetic acid. Samples were heated in 100 °C before being placed in the boiling acid, then washed in water, dried, and the loss in weight noted. *Sudden change of temperature:* A sample of each enamel was heated in muffle to 1500 °F, allowed to cool just below redness, and then thrown into water at 60 °F. (This test was tried having the sample at higher temperatures, but it was too severe. The first test mentioned was most satisfactory.) *Solubility in sulphuric acid:* (1) Everything else being constant, the solubility decreases directly as the OR increases. (2) Everything else being constant, the solubility decreases as the contents of aluminum oxide increase. (3) Everything else being constant, the solubility decreases as boric oxide decreases. *Solubility in acetic acid:* Results of the acetic acid test are not so sharply defined as in the sulphuric acid test, but in general the statements made concerning solubility in sulphuric acid also hold true with regard to acetic acid; 75% acetic acid has very much less solvent action than has 1% sulphuric acid. This is shown by the very low loss per square inch in weight and by the fact that so many of the samples retain their gloss after the acetic acid treatment, while not one showed any gloss after sulphuric acid treatment. The gloss was affected to some extent on all samples by acetic acid, but the effect was very

slight on those high in RO and Al_2O_3. *Proposed standard solubility test:* Weigh clean, dried dish to 0.001 g.; fit with rubber gasket, heat vessel filled with water to boiling, also heat solution of 1% sulphuric acid to boiling; empty vessel and fill it with the hot sulphuric acid and boil for 15 minutes; clean, dry, and note loss in weight; loss should not exceed 0.008 g. per square inch. Discussion by Price, Binns, Bruner, and L. Shaw. (*Chem. Abs.*, **5,** 168 (1911); *Chem. and Ind.*, **29,** 1310 (1910).)

Shaw, J. B.

PROCESS OF MAKING SANITARY WARE. *Trans. Amer. Ceram. Soc.*, **15,** 467 (1913).—The body is 1.5 volumes of plastic fire clay, 1 flint clay, and 1 grog, ground through 10-mesh. It is blunged with a mixture of 95% water, 5% sodium silicate solution (50°Bé). This mixture is heated by steam as hot as the hand will stand. The consistency is the vital point of the process. At casting consistency the body contains only 10% water. For a thickness of one inch about 5 to 6 hours is required between pouring and drawing the molds; blocks 8 x 10 x 12 inches required 20 hours. After drawing molds the ware is trimmed and smoothed and dried on a brick floor underlaid by direct-fired flues. The slip is then painted on and finally the glaze. Firing is at cones 8 to 10. Defects are tabulated and described. Experiments with slips showed that (1) $CaCO_3$ up to 10% may be used but is not necessary; (2) if more than 40% clay is used feldspar must exceed 15% unless more than 1% $CaCO_3$ is added; (3) more than 10% $CaCO_3$ makes the slip too vitreous; (4) slips with less than 40% clay and with 15% or more feldspar are too vitreous; (5) slips with over 45% feldspar are too vitreous and liable to craze; (6) good slips may be found anywhere within the limits of feldspar 20 to 45, flint 10 to 40, china clay 30 to 60, $CaCO_3$ 0 to 10%. (*Chem. Abs.*, **8,** 807 (1914).)

Shaw, J. B.

FLUORIDES AS OPACIFIERS. *Trans. Amer. Ceram. Soc.*, **16,** 577 (1914).—Carefully compiled list of questions as to possibilities when fluorides are used. Also a list of theories that have been advanced. (No data.) Some of the theories that have been offered are: (1) The opacity is produced by SiF_4, which goes into solution in the glass when hot and is precipitated out and held in suspension when the glass cools. (2) The opacity is caused by SiF_4, not by the gas in itself but by some characteristic crystalline structure which the glass is caused to assume by the SiF_4. (3) Opacity is caused by the formation of sodium-silicofluoride, Na_2SiF_6. (4) Opacity is due to precipitation of Al_2F_6. Alumina and fluorine are both essential in producing opacity with fluorides. (5) Opacity is due to precipitation of Al_2O_3, all the fluorine being evolved as SiF_4. (6) Bubbles. Discussion by R. D. Landrum and A. Silverman. (*Chem. Abs.*, **8,** 3713 (1914); *Chem. and Ind.*, **33,** 1048 (1914).)

Shaw, J. B.

AMERICAN CLAYS FOR FLOATING ENAMELS. *Trans. Amer. Ceram. Soc.*, **19,** 339 (1917).—An American clay has been found that ranks fairly well with the German Valender clay when used in enamels. Because a clay is a ball clay it does not necessarily follow that it is good for floating enamels and glazes. Florida clay is better for this purpose than Kentucky ball clay or English M and M. A simple method has been devised for measuring the viscosity and the relation between the viscosity and specific gravity (which can be determined approximately by weighing a known volume) gives a value which represents the consistency. By using this value, enamels or glazes or slips can be kept constant, and thereby more nearly uniform results obtained. Discussion by Denmead, Smith, Brown, Staley, Poste, Beecher, Binns, and MacDougall. (*Chem. Abs.*, **12,** 608 (1918); *Chem. and Ind.*, **37A,** 512 (1918).)

Shaw, J. B.

ENAMELS FOR SHEET IRON AND STEEL. Bur. Stand., *Tech. Paper*, No. 165.—This is a general treatise dealing with the technology of enameling sheet iron and steel. It has been prepared to answer the demand for a treatise dealing with the technology of the manufacture of vitreous enamels for these metals. This subject is not adequately treated in any existing publication. An effort was made to obtain reliable and authentic information wherever available and to correlate it in such a manner as to shed some light on the problems encountered by enamelers. The treatise is a compilation of data dealing with the subject of enameling from various publications, from S.'s notebook, from the files of the Bureau, and from the experience of men engaged in the enameling industry in this country. Among the subjects dealt with in connection with the properties and preparation of steel for enameling are physical and chemical requirements, sandblasting, treatment preliminary to pickling, and methods of pickling. A chapter is devoted to the properties of the raw materials used in compounding enamels. The relations between chemical composition and physical properties of enamels are discussed fully. The procedures used in the preparation, applying, and firing enamels are described in detail. The calculation of enamel formulas is fully explained and examples are given. The physical properties of enamels are dealt with in some detail and resistance of enamels to chemical action is fully discussed. (*Jour. Amer. Ceram. Soc.* (Abs.), **3**, 771 (1920); *Chem. Abs.*, **15**, 2163 (1921).)

Shaw, J. B., and Shaw, L.

DETERMINING THE COST OF ENAMELED STEEL COOKING UTENSILS. *Trans. Amer. Ceram. Soc.*, **14**, 510 (1912).—Outline of the method used in figuring a cost system for The West Lafayette Mfg. Co.

- Machine Room Cost
  - Labor
    - Cutting blanks
    - Oiling blanks
    - Pressing shapes
    - Spinning
    - Beading
    - Riveting
  - Steel
    - Sheet steel
    - Rivets
    - Handles
- Enamel Room Cost
  - Labor
    - General
    - Scaling
    - Pickling
    - Dipping
    - Beading
    - Firing
  - Material
    - Acid
    - First coat enamel
    - Second coat enamel
    - Finish enamel
    - Fuel
- Packing Room Cost
  - Labor
    - Packing
    - Sorting
    - Wrapping
  - Material
    - Straw and paper
    - Crates
- Other Expenses
  - Office
  - Management
  - Power
  - Interest
  - Depreciation
  - Sundry

(*Chem. Abs.*, **7**, 230 (1913).)

Shepard, Walter L.

MAKING ENAMELED ARTICLES. U. S. Pat. 1,072,047, Sept. 2, 1913.—The process which consists in making a recessed base, having fixed metallic partitions, dividing it into areas, filling some of the areas with enamel, firing the enamel, removing the partitions, filling the remaining areas or spaces with enamel and firing the areas last filled.

Shimomura, S.

ENAMELED WATCH-DIAL. *Jour. Jap. Ceram. Assn.*, **32** [375], 93 (1924).—*I. Relation between ground-coat and cover-coat frits:* (1) Coefficient of expansion (cubical): this must be about 300 x 10^{-7} and 280 x 10^{-7} for ground-coat and cover-coat frits, respectively. (2) Melting points: 750° and 800° for ground-coat and cover-coat frits, respectively, are the most desirable. *II. Raw materials:* Clay, feldspar, B_2O_3, and borax are not used for cover-coat frit. As_2O_3 is the only opacifier which gives excellent results. *III. Experiments on the frits:* No. 1 in the table, prepared after an excellent Swiss cover-coat enamel, gives a transparent glass which can not be opacified by further increases of As_2O_3. Reduction of alkalis makes the glass opaque, though it becomes too refractory. By increasing Pb_3O_4, light opaque glass is obtained. It is improved further by adding more As_2O_3, though it makes the enamels too brittle. This defect is overcome by changing the amounts and ratio of the alkalis. Thus a pretty good enamel, No. 11, is obtained.

TABLE I. COVER-COAT ENAMELS

No.	Quartzite	Pb_3O_4	As_2O_3	K_2CO_3	Na_2CO_3	KNO_3
1	100	120	13	36	45	5
11	100	170	16	22	3	4
14	100	163	17	25	3	4
17	100	160	19	24	5	4

Experiments on the ground-coat frit for No. 11 are described. A batch composed of quartzite 100, Pb_3O_4 140, feldspar 70, slaked lime 25, Sb_2O_3 15, Na_2CO_3 50, and KNO_3 10, gave a satisfactory result. The use of fluorspar was abandoned, as it caused bubbling. Introduction of B_2O_3 seems to make the enamels too hard. Experiments on the further improvements of the enamel No. 11 are described. Increase of K in the enamel No. 11 at the expense of Pb made it more bright and fit for charcoal pressing on account of its softness, *e.g.*, enamel No. 14 is far better than No. 11. Further decrease in Pb made the enamel too soft, though better results in charcoal pressing were obtained. This defect was overcome by replacing some K with Na. Enamel No. 17 is an example of this type. A ground-coat frit from quartzite 100, Pb_3O_4 155, feldspar 70, slaked lime 25, SnO_2 50, Na_2CO_3 52, KNO_3 10, was excellent for use with these cover coats. *IV. Grinding and washing of frits:* Cover-coat frits must be air cooled and then ground to pass No. 120 sieve. Then they are washed with H_2O and HNO_3. They are used as cover-coat enamel as they are. Ground-coat frits may be poured in H_2O, other procedures being similar to the above. A ground-coat enamel is made by regrinding a mixture of a ground coat and a cover coat in equal parts. *V. Firing:* Ground coat was fired for 4 minutes at 750°, while cover coat was heated for about 15 minutes at 850°. (*Ceram. Abs.*, **4**, 59 (1925); *Chem. Abs.*, **19**, 1336 (1925); *Chem. and Ind.*, **44B**, 100 (1925).)

***Shively, R. R.**

ANNEALING PORCELAIN PARTS PROVED TO BE INTERESTING. See *Enamelist* (this *Bibliography*, p. 106).

Siemens

ENAMELING OVEN WITHOUT MUFFLE. *Maschinenb.*, **25**, 2. (*Rep. der Tech. Lit.*, p. 118 (1888–1890).)

Siemens, F.

DIRECT ENAMELING BY MEANS OF HIGHLY HEATED GASES PURIFIED FROM DUST AND TAR. German Pat. 317,021, Feb. 5, 1918.—The articles to be enameled are ex-

posed directly to flue gases for the purpose of melting down the enamel. (*Chem. and Ind.*, **39A**, 409 (1920).)

Sievert, Christian A.

ENAMELING TABLE. U. S. Pat. 645,517, March 13, 1900.—In an enamel-dusting table or machine, the combination with a rotary enameling table, of a pivoted or swinging frame or support on which the enameling table is mounted, a foot lever or treadle, and connections from the same to the shaft of the rotary table for rotating the table.

Skamel, E.

ENAMELING CAST IRON. *Giesserei Ztg.*, **11**, 585, 606 (1914).—Composition of enamel for cast-iron goods. The making of the enamel, tables of formulas.

***Smallwood, A.**

ENAMELING FURNACE. See Incandescent Heat Co. Ltd. (this *Bibliography*, p. 159).

***Smith, C. A.**

MACHINERY FOR DISTRIBUTING ENAMELING POWDERS. See Walters, W. (this *Bibliography*, p. 327).

Smith, Herbert M.

METHOD OF PRODUCING AND APPLYING ENAMEL COATINGS TO METALLIC SURFACES. U. S. Pat. 1,425,612, Aug. 15, 1922.—As a part of the process of enameling, applying an enamel mixture to a surface which is to be coated, thereby distributing the material over the surface, subjecting it to a fusion temperature and air blast thereto while the fusion is going on. (*Ceram. Abs.*, **1**, 334 (1922); *Chem. and Ind.*, **41A**, 756 (1922).)

Smith, Joseph

ENAMELING METALS. See Atkinson, Wm. (this *Bibliography* p. 9).

Snyder, L. C.

THEORIES CONCERNING THE PLASTICITY OF CLAYS. *Min. Sci.*, **64**, 106. (*Chem. Abs.*, **5**, 3898 (1911).)

Soc. Migeot Freres et Arnould

ENAMELS. British Pat. 273,260, Aug. 17, 1927.—Leadless enamels are formed with a barium or strontium content. An example of a white opaque enamel is given as borax 9.3%, feldspar 16.9%, carbonate of lime 8.86%, baryta 24.6%, boric acid 5.65%, zinc 3.65%, alkalis 6.43%, antimony 7.52%, fluorspar 5.3%, phosphate of lime 9.53%, cryolite 1.13%, alumina 1.13%, while an example of a transparent enamel of the ceramic type is given as borax 21%, boric acid 11.25%, baryta 25%, feldspar 8.75%, alkalis 11%, lime 11.5%, zinc 10%, alumina 1.5%. (*Ceram. Abs.*, **6**, 505 (1927).)

Sommer, A.

KILN ESPECIALLY FOR ENAMELED WARE. German Pat. 325,747, Dec. 15, 1918.—The kiln is heated indirectly by hot gases conveyed through channels of refractory brick running along the side walls and roof, but at a distance from the same. (*Chem. and Ind.*, **40A**, 391 (1921).)

Sommer, F., and Groth, M.

ENAMELS AND GLAZES. U. S. Pat. 1,564,907, Dec. 8, 1925.—Both unfired and fired clay are used together in enamels and glazes such as may also contain ZrO_2 in order to avoid formation of blisters or bubbles. See British Pat. 197,933. (*Chem. Abs.*, **20**, 487 (1926); *Chem. and Ind.*, **44B**, 382 (1925); **45B**, 90 (1926).

Sonntag, S. and A.

ENAMELED METALWARE. German Pat. 239,252, Aug. 13, 1910; French Pat. 419,433, Aug. 17, 1910; British Pat. 19,233, Aug. 16, 1910.—The cleaned surface is wet with water to which a glutinous substance has been added and the enamel powder sifted upon the moist surface, the excess over that which can be retained by the adhesive falling off. This treatment is repeated until the desired thickness is attained, whereupon the article is fired in the usual manner in an oven. (*Chem. Abs.*, **6**, 2155 (1912); *Chem. and Ind.*, **29**, 1383 (1910).)

Sortwell, H. H.

SOLUBILITY AND FUSIBILITY OF SOME FELDSPAR FRITS. *Jour. Amer. Ceram. Soc.*, **4**, 446 (1921).—Twenty frits were made covering the field: 10 to 50% fused borax, 20 to 90% feldspar, and 0 to 30% calcium oxide. (1) The solubilities of the entire field were found to be less than 1.5% showing that the variations in composition in this field had less effect on the resulting solubility than the degree of smelting, and that all of the frits were sufficiently insoluble for use in glazes. The inclusion of CaO in the frit had a beneficial effect in decreasing the solubility. (2) The fusibilities were found to vary from 660 to 1050°C. Substitution of CaO for feldspar up to 10%, maintaining the borax constant, increased the deformation point, but further substitution in this direction had little effect. Substitution of either CaO or feldspar for borax, appeared to raise the deformation temperature about the same in either case. A large part of the field was sufficiently fusible for easy working in the frit kiln. (*Chem. Abs.*, **16**, 149 (1922).)

***Souder, W. H.**

CAUSES AND CONTROL OF FISHSCALING OF ENAMELS FOR SHEET IRON AND STEEL. See R. R. Danielson (this *Bibliography*, p. 88).

Souder, W. H., and Hidnert, P.

THERMAL EXPANSION OF INSULATING MATERIALS. U. S. Bur. Stand., *Bull.*, No. 15, p. 387 (1919).—The experimental work was done on porcelain, marble, and phenol condensation products. (*Chem. Abs.*, **14**, 3185 (1920).)

Speer, Arthur R.

METHOD OF ENAMELING THE INTERIOR OF SHEET-METAL VESSELS. U. S. Pat. 866,821, Sept. 24, 1907.—The process of enameling the interior of closed vessels of sheet metal consisting in filling the interior of the vessel with liquid enamel under pressure to entirely cover all surfaces, joints, etc., then emptying the surplus, and then subjecting the vessel and its interior coating to a hardening heat.

Speller, F. N., and Chappell, E. L.

PRACTICAL APPLICATION OF INHIBITORS IN PICKLING OPERATIONS. *Chem. Met. Eng.*, **34**, 341 (1927).—Small amounts of certain materials added to acid solutions greatly decrease their rate of attack on metals without markedly slowing down their rate of solution of oxide. This effect is more marked with high acid concentration than with low, and is less marked at high temperatures of pickling. This inhibiting action is apparently catalytic. The authors list as commercial inhibitors, acid sludge, bran, and materials containing nitrogen bases. Plant tests are cited, showing large savings of acid through the use of inhibitors, in addition to preservation of the metal surface, and reduction of acid fumes in the air. It is noticeable, however, that in the experiments cited the use of inhibitors in every case increased the pickling time appreciably. (*Ceram. Abs.*, **6**, 428 (1927).)

Spencer, H. R.

ECONOMIC TREND OF ENAMELING BUSINESS. *Bull. Amer. Ceram. Soc.*, **6**, 281 (1927).—This business is in such a condition that there are now means and machines for a greater production that can normally be absorbed. Enameling started as a distinctive industry and is now in part separate, and in part a department of stove and refrigerator plants. Four plans to be followed in the future are: (1) a number of enamelers may fail, (2) the enameler may become merely a departmental adjunct of the stove or refrigerator business, (3) he may develop new markets, (4) he may follow the course already pointed out by the stove industry, the steel industry, the railroads, and many other industries, *i.e.*, the formation of large corporations. The advantages of the last-named plan are pointed out and the suggestion that it be followed is implied. (*Ceram. Abs.*, **6**, 504 (1927).)

Spitz, G.

DETACHING ENAMEL FROM ENAMELED OBJECTS. French Pat. 370,986, Oct. 31, 1906; British Pat. 5273, Mar. 5, 1907.—A solution of caustic soda or oxalic acid at 100°C is used, either with or without a quantity of oxidizing medium. Pressure of 7 to 15 atmospheres used. (*Chem. Abs.*, **2**, 204 (1908); *Chem. and Ind.*, **26**, 257 (1907).)

Spitz, G.

REMOVING ENAMEL FROM SCRAP ENAMELED METAL. U. S. Pat. 1,055,678, Mar. 11, 1913.—Consists in heating to above 100° in a water solution of sodium hydroxide of a strength of at least 15°Bé under a pressure at 7 to 15 atmospheres. See preceding abstract. (*Chem. Abs.*, **7**, 1593 (1913); *Chem. and Ind.*, **26**, 257 (1907).)

Spitz, G.

REMOVING ENAMEL FROM ENAMELED GOODS. U. S. Pat. 1,065,401, June 24, 1913.—Enameled ware is covered with a paste of a mixture of NaOH and Na_2CO_3, heating and dissolving the soluble compounds from the ware with water. (*Chem. Abs.*, **7**, 2845 (1913); *Chem. and Ind.*, **32**, 792 (1913).)

Spon and Chamberlain

ENAMELING CAST-IRON BATHS. *Spon's Workshop Recipes*, **2**, 160–63 (New York, 1909). Composition and process of commercial enameling.

Sprechsaal, **12**, 426.

PREPARATION FOR ENAMEL MANUFACTURE. (*Rep. der Tech. Lit.*, p. 142 (1879–1881).)

Sprechsaal, **22**, 370.

DEFECTIVE TIN GLAZES.—When the white enamel cracks on drying and does not become smooth when re-baked, the contraction on drying must be diminished by fritting the materials strongly and melting them. If the enamel does not melt sufficiently easily it must be mixed with more lead oxide. (*Chem. and Ind.*, **8**, 984 (1889).)

Sprechsaal, **33**, 191 and 229.

TURBIDITY PRODUCED BY FLUORINE COMPOUNDS IN CRYOLITE AND FELDSPAR GLASS.—Although the action of fluorine compounds in producing turbidity has been questioned, it is proved by the behavior of a mixture of sand 100 parts, soda 20, potash 6, calcspar 6, and cryolite 16 parts, when fused for five hours; the presence of alumina in sufficient quantity to yield an insoluble deposit in excess (as supposed by Benrath) being precluded. Proposals have been made to replace cryolite by artificial cryolite, or by

a silico-fluoride of tin or cerium, but such compounds are more costly, and the silico-fluoride could be more advantageously replaced by antimony fluoride. The expense of preparing opaque glass may also be reduced by dispensing with the use of saltpeter, which favors the liberation of fluorine, and thus facilitates the corrosion of the glass pots, and employing metallic antimony instead. (*Chem. and Ind.*, **19**, 663 (1900).)

Sprechsaal, **33**, 306 and 337.

ENAMEL FOR IRONWARE.—A cloudy, gray appearance can be imparted to ware, coated with ground enamel, by dipping and working about in a thin white enamel and refiring, the whole being afterward glazed with transparent cover enamel. Spotty enamel is prepared by adding a solution of some metallic salt-cobalt or nickel sulphate, etc., to the enamel mass before use, and then dusting the moist layer of enamel with "ammonia-soda," the corresponding metallic oxide being precipitated and appearing in the form of spots after firing. Similar effects are obtainable by spraying the ware with a cover enamel of a different color to that of the ground layer. Marbling is produced by sprinkling colored enamel on the unfired cover enamel, and turning the ware round and round so as to cause the sprayed mixture to run into veins. For retouching defective places, an enamel of the following composition may be used: colorless gum damar, 25 parts; copal, 25 parts; Venice turpentine, 20 parts; zinc white, 30 parts; stirred with sufficient alcohol to make a stiff paste. The yellowish tinge can be corrected with Berlin blue. For blue enamel, the zinc white is replaced by cobalt blue; for brown, with manganese brown, etc. Decorative effects are produced by means of fusible pigment preparations and bright gold, as well as by overlaid enamel. Printed, handpainted, and transfer designs are also used. A few typical frit recipes for ironware enamels are given.

	Ground		White ground	White		
	I	II		I	II	III
Borax	32	41	25	26	18	15
Quartz sand	20	16	20	8	17	19
Feldspar	28	30	38	32	44	39
Calcspar	9					7
Ammonia soda	6	6	8	9	6	
Fluorspar	3	4	2	6		1
Saltpeter	2	3	1	3	2	6
Manganese dioxide	0.50					
Cobalt oxide	0.18	0.15				
Nickel oxide		0.10				
Cryolite			6	5	13	12
Tin oxide				11		
Magnesia						1

For use these frits are ground (not too finely) with clay in the following proportions:

	(%)	(%)	
Ground I	92	Clay 8	
Ground II	95	Clay 5	
White ground	95	Clay 5	
White I	86	Clay 6	Tin oxide 8%
White II	96	Clay 4	
White III	84	Clay 6	Tin oxide 10%

(*Chem. and Ind.*, **19**, 746 (1900).)

Sprechsaal, **54**, 490.

NEW MEURER ENAMEL SPRAYING PROCESS.—Meurer with the aid of the Schoop patents developed a spray whereby enamel is molten and sprayed on metals, etc. The spray has attached to it a glass container in which fine-ground enamel similar to that

used for kiln-fired enameling is placed. This powder is drawn out of the container by suction and mixed with compressed air or oxygen which is forced through one jet of the burner. Combustible gases as hydrogen, acetylene, or luminating gas are forced out of another jet. With this spray a white enamel as well as others may be applied without a ground coat. Enamels contain potash, soda, lime, fluorspar, cryolite, and clay which increase their elasticity. The ground coats used with kiln-fired enamels are lacking in these constituents and therefore produce enamels with inferior elasticity. The sprayed enamels are more resistant to blows and sudden temperature changes than the kiln-fired enamels which may be partly due to the fact that they can be applied thinner than the kiln-fired enamels. In firing enamels in a muffle kiln the carbon, silica, manganese, and phosphorus of the iron are liberated, causing reducing conditions. This is especially harmful to reducible oxides such as Sn, Zn, Pb, and Cu oxides. By the new method the source of this trouble is avoided. This method may also be used for repairing enamelware which heretofore has caused many costly delays. In repairing with the spray the combustible gas alone is first used to heat slowly the ware to be repaired. This is done by gradually localizing the heat around the area to be repaired and forcing the molten enamel against the chipped portion. The piece is then allowed to cool slowly by covering the same with an asbestos board. (*Jour. Amer. Ceram. Soc.* (Abs.), **4**, 787 (1921); *Chem. Abs.*, **15**, 2975 (1921).)

Sprechsaal, **59**, 78 (1925).

OPACIFIERS FOR ENAMELS. Methods for opacifying enamels are reviewed. (*Ceram. Abs.*, **5**, 143 (1926); *Chem. Abs.*, **20**, 1894 (1926).)

Springer, L.

EXPERIMENTS WITH ENAMELS FOR GLASS PAINTING. *Keram. Rundschau*, **34**, 85 (1926).—White enamels composed of 70 Pb_3O_4, 30 SiO_2, and 1 As, and also 70 Pb_3O_4, 40 SiO_2, and 20 calcined borax are used as a base for preparing colors for glass painting. These are mixed with the customary coloring oxides to produce the desired colors. More of the coloring oxides are required for preparing these colors than for preparing similar colored enamels. For example, a dark blue enamel may be prepared with white enamel plus 1 CoO but to prepare a dark blue glass color 3 parts of CoO are required with the same quantity of enamel. (*Ceram. Abs.*, **6**, 574 (1927).)

Springer, L.

PRECAUTIONS TO BE TAKEN IN REPLACING SODA OR POTASH (IN GLASSES AND ENAMELS). *Sprechsaal*, **52**, 362 (1919).—Potash from the sugar-beet usually contains 80 to 85% K_2CO_3, 7 to 15% Na_2CO_3, 4 to 7% K_2SO_4, and 3 to 4% KCl. Calcined Stassfurt potash contains 97 to 99% K_2CO_3, 0.05 to 1.25% KCl, and only traces of other substances. Hydrated or "crystalline potash" contains little potassium chloride, but 17.4% of water, and therefore only 80 to 83% K_2CO_3. Potash derived from wood or vegetable ashes corresponds to that from sugar-beet. For glasses and enamels, potash should contain the highest possible percentage of potassium carbonate and a minimum of other constituents. Potash with a high soda content is useless for potash glasses. Potassium chloride is an inert impurity which is volatilized, and, if present, may hasten the fining of the batch. Small proportions of potassium sulphate are harmless, but larger ones form a scum on the molten glass and tend to color the glass. Phosphoric salts in small quantities are harmless. In comparing samples of potash from different sources, the influence of the various impurities should be fully recognized, as they often have a marked effect on the behavior of the glass batch. The addition of a little soda as glaubers' salt or common salt (when unobjectionable) will sometimes convert a "useless" potash into a satisfactory material, as the purer potash glasses are less fusible

than those containing a little soda. In Germany glaubers' salt or sodium sulphate is now seldom used, having been replaced by the purer Solvay or ammonia soda which contains 97 to 99% Na_2CO_3, 0.3 to 2% NaCl, and traces of other substances. Some firms mix it with 8 to 10% of sodium sulphate (saltcake) which enables the glass to fuse more readily and facilitates the fining. "Light" and "heavy" soda differ solely in specific gravity, the difference being due to the temperature of calcination. The "heavy" form melts more easily and uniformly, but the glass requires a longer fining. Seeds due to the infusibility of the soda may be avoided by replacing part of the soda by saltcake or by replacing half of the soda with 98 to 100% Na_2CO_3 by that containing 90 to 92%. An excess of sodium sulphate is particularly objectionable in the production of glass colored yellow by carbon, as the greater the percentage of glaubers' salt the deeper will be the color, an increase of only 5% of the salt sometimes spoiling the color of the glass. In substituting potash or soda from sources other than those generally used the chemical composition should be ascertained in detail and any differences taken into consideration. (*Chem. Abs.*, **14,** 809 (1920); *Chem. and Ind.*, **38A,** 902 (1919).)

Sproesser, William Charles

CONTROL OF SOFTENING TEMPERATURE OF VITREOUS MATERIAL. U. S. Pat. 1,565,598, Dec. 15, 1925.—The method of potentially increasing the softening temperature of vitreous material a desired amount comprises applying a material to the surface thereof to react chemically therewith. (*Ceram. Abs.*, **5,** 47 (1926).)

Spurrier, H.

USE OF OX GALL IN PREVENTION OF CRAWLING OF GLAZES. *Jour. Amer. Ceram. Soc.*, **5,** 937 (1922).—The use of ox gall in solution will prevent the crawling of glazes entirely; the action is probably due to the lessened surface tension.

Staley, H. F.

PRINCIPLES OF ENAMELING. I. *Ceramist*, **4,** 6 (1924).—Articles for the special benefit of the man who has not had technical training. The methods of calculating melted weight and percentage loss on melting and coefficient of expansion without the use of chemical symbols are shown. (*Ceram. Abs.*, **3,** 336 (1924).)

Staley, H. F.

PRINCIPLES OF ENAMELING. II. *Ceramist*, **4,** 87 (1924).—The properties, mining, and preparation, function in enamels, importance of accurate chemical analysis, and control of feldspar. In dry-coat enamels for cast iron, feldspar constitutes 30 to 35% of the raw enamel mixture, or 36 to 42% of the melted enamel. In sheet-steel enamels 20 to 60% of feldspar is employed. In wet-coat enamels for cast iron from 0 to 30% feldspar is used. Except in a few ground coats for dry-coat cast-iron enamels, the feldspar is melted in the frit. The following are the factors by which the percentage amounts in the melted enamel of pure minerals must be multiplied to give the effect on the comparative figures usually employed for controlling expansion of enamels.

Mineral (pure)	Coeff. factor for each per cent
Potash feldspar	2.87
Soda feldspar	2.70
Lime feldspar	3.18
Quartz	0.80

Variation in the relative amounts of feldspar in any one standard commercial brand does not have a marked effect upon the coefficient of expansion, but comparatively small variation in the amount of free quartz has a decided effect on the coefficient of expansion.

The determination of free quartz by microscopic examination of the feldspar is accurate only to about 5% of quartz, which is not sufficiently close for such purposes. The analytical determination of total silica is not sufficient to show the amount of free quartz present. The only satisfactory method is a complete and careful chemical analysis. S. shows that the increase of silica content above certain minimum decreases the coefficient of expansion uniformly. After a certain silica content is agreed upon the feldspar shipper should maintain the variation of the silica within 0.5% of the agreed figure, otherwise chipping or crazing may follow. (*Ceram. Abs.*, **4**, 59 (1925); *Chem. Abs.*, **19**, 1336 (1925).)

Staley, H. F.

PRINCIPLES OF ENAMELING. III. *Ceramist*, **4**, 167 (1924).—Specifications for feldspar. S. shows by calculation of free quartz content the nature of the difficulties which may be anticipated with small variations in the silica and the feldspar. The relative influence of potash and soda in enamel is discussed. It is doubtful whether the effect of the kind of alkali present in feldspar has ordinarily any important effect on enamel composition. In purchasing feldspar it would seem advisable to specify the relative amounts of potash and soda with rather wide limits. S. doubts whether the amount of lime present in feldspar has any effect on enamels. Calcium oxide can be bought at a low price in the form of whiting; therefore in purchasing, the maximum amount of lime permissible should be specified. In general, the amount of magnesium oxide is less than 0.5% except in certain feldspar deposits which are not being worked at present. The action of these feldspars should be carefully studied before they are substituted. The maximum amount of magnesium permissible should be specified. The amount of alumina present in feldspar is fixed by the per cent of potash, soda, and lime. Any material excess is an indication either of the presence of kaolin or of poor analysis. The presence of kaolin may be determined by a mineralogist. Iron oxide may be present in amounts less than 0.5% which is permissible for feldspar used in making white enamels. This limit may be raised to 1%. This, however, should be checked by trial. The amount of free silica may be calculated from analysis. The greatest objection to its variation is the effect it has upon fusibility and thermal expansion. Free silica, also, can be more cheaply purchased in the form of ground quartz. Free quartz is permissible in the highest grade feldspar in amounts up to 5%. Higher percentages may be present provided the shipments do not vary. S. proposes specifications for several types of feldspars. The cone fusion test, the color on fusion, screen test, moisture content, and influence of fineness of grain are briefly discussed. (*Ceram. Abs.*, **4**, 60(1925); *Chem. Abs.*, **19**, 1336 (1925).)

Staley, H. F.

PRINCIPLES OF ENAMELING. IV. *Ceramist*, **4**, 229 (1924).—Calculation of percentage compositions of melted enamel by fluorides and for loss of silica assuming that the fluorides are decomposed and that fluorine volatilized as silicon fluoride. (*Ceram. Abs.*, **4**, 60 (1925).)

Staley, H. F.

PRINCIPLES OF ENAMELING. V. *Ceramist*, **4**, 351 (1924).—A summary of the recent work on fishscaling as reported by Shaw, Danielson and Souder, Grainer, Sweely, and Geisinger. S. reviews and analyzes their results and gives the following summary: (1) Fishscaling in enamels on sheet metal consists of rupture of the enamel due to compressive stresses. The causes of these compressive stresses may be (*a*) higher coefficient of thermal expansion and contraction of the metal than of the enamel; (*b*) uneven cooling of the piece of ware, especially when this produces warping. (2) Whether the stresses

operating will cause the enamel to rupture will depend upon the magnitude of the stresses, the form and thickness of the enamel coating, the breaking strength of the enamel, its elasticity, and its adhesion to the metal. (3) Factors affecting difference in thermal expansion and contraction of metal and enamel coating are: (*a*) composition of enamel batch, (*b*) degree of melting of batch, (*c*) amount and character of raw additions, (*d*) degree of firing of enamel coating. (4) Factors affecting uneven cooling and warping are: (*a*) thickness of metal and enamel coating in various parts of piece, (*b*) size and shape of piece, (*c*) rate of cooling, (*d*) character of metal (warping only). (5) Factors affecting adhesion of enamel to metal are: (*a*) composition of enamel batch, (*b*) degree of melting of enamel, (*c*) amount and character of raw additions, (*d*) degree of firing of enamel coating, (*e*) thickness of enamel coating. (6) Factors effecting adhesion of enamel to metal are: (*a*) composition of the enamel, (*b*) method of preparation and application, (*c*) degree of firing of enamel coating, (*d*) structure of metal surface, (*e*) cleanness of metal surface. (*Ceram. Abs.*, **4**, 61 (1925); *Chem. Abs.*, **19**, 1336 (1925).)

Staley, H. F.

PRINCIPLES OF ENAMELING. VI. *Ceramist*, **5**, 29 (1924).—Investigation made by S. on the influence of the size of grain of feldspar leads him to conclude that enamelers cannot use 40-mesh feldspar to advantage, that there is some advantage in using 140-mesh instead of 90-mesh, and that there is no advantage in using 200-mesh. In white enamels containing lead oxide and antimony, use of coarse-grained feldspar lengthens time of melting to such an extent that blue tints are likely to be developed. The enamel composition used was a high grade sodium antimonate enamel. (*Ceram. Abs.*, **4**, 61 (1925).)

Staley, H. F.

PRINCIPLES OF ENAMELING. VII. *Ceramist*, **5**, 96 (1924).—Discussion of the derivation of the factors used in the calculation of the coefficient of thermal expansion with special reference to recent observations by Turner and his associates and investigators of the Bureau of Standards. While the factors possibly are not accurate from the standpoint of highly specialized physical laboratories nevertheless they are satisfactory as a guide in the technical control of enamel mixtures. (*Ceram. Abs.*, **4**, 61 (1925).)

Staley, H. F.

TURNING A POOR ENAMELING FURNACE INTO A GOOD ONE. *Ceramist*, **5**, 144 (1924).—By converting an inefficient closed muffle type furnace into a semimuffle type furnace, 70 to 75% fuel saving was accomplished. Data and diagrams are given. (*Ceram. Abs.*, **4**, 299 (1925).)

Staley, H. F.

PRINCIPLES OF ENAMELING. VIII. *Ceramist*, **6**, 384 (1925).—(*Ground-Coat Enamels for Dry-Process Enameling of Cast Iron.*) Very little is known about the fundamental principles of compounding and preparing ground-coat enamels. S. states requirements of a good ground-coat enamel of the glassy type. S. compares several ground-coat enamels that have been used successfully for long periods of time and calculates their "refractory value." The refractory value of a ground is supposed to indicate the general behavior of the ground when heated. The percentage of raw additions, relation of gloss to strength of bond, and further problems for research are pointed out. (*Ceram. Abs.*, **4**, 331 (1925).)

Staley, H. F.

PRINCIPLES OF ENAMELING. IX. *Ceramist*, **6**, 554 (1925).—(*Cleaning of Iron and Steel.*) The more important substances to be removed from iron and steel to be used in

enameling are (1) oils and greases, (2) oxides or scale. The removal of oils is called "cleaning." The use of organic solvents produces a remarkably clean ware. Because of their expense, evaporation losses, fire hazard, and injurious vapors, solvents should only be used for removing nonsaponifiable oils. Saponifiable oils should be removed by alkaline solutions. In preparing solutions, the chemicals that can be used are, in the order of their efficiency, caustic soda, trisodium phosphate, soda ash, sodium silicate, and borax. Hard water should be avoided. With saponifiable oils the cleaning action depends on emulsification and subsequent saponification. The soap formed also exercises a cleaning action. With nonsaponifiable oils the cleansing by alkaline solutions depends on emulsification and subsequent gravity separation. The stability of the emulsion can be increased by (1) increasing alkalinity, (2) using more solution, (3) adding small amounts of soap. Too much stability makes the subsequent gravity separation difficult. The addition of solid particles of colloidal size and agitation also increases stability. In electrolytic cleaning the main cleaning action results from the production of finely divided gases. Cutting and drawing oils should be so chosen as to contain just sufficient saponifiable oils to give a stable emulsion during cleaning. S. gives formulas for cleaning solutions. A 3rd method of cleaning is by heating or "firing off." This also helps to remove strains. S. gives the particulars of good operation. (*Ceram. Abs.*, **4**, 332 (1925).)

Staley, H. F.

PRINCIPLES OF ENAMELING. X. *Ceramist*, **7**, 286 (1926).—(*Pickling of Iron and Steel.*) The addition of sodium chloride to a sulphuric acid bath accelerates the pickling action. The use of colloidal addition agents or inhibitors decreases pitting and excessive solution of the metal. The hydrogen absorbed by the metal during pickling causes blisters during the enameling. S. recommends washing the pickled ware in boiling hot water to remove the hydrogen rather than preventing absorption by the use of dilute acids, thus slowing up pickling. Electrolytic pickling has attained little commercial importance. (*Ceram. Abs.*, **5**, 142 (1926); *Chem. Abs.*, **20**, 1894 (1926).)

Staley, H. F.

PRINCIPLES OF ENAMELING. XI. *Ceram. Age*, **10**, 46 (1927).—Although the number of instances of poisoning due to the use of lead-bearing enamels are so few as to be of minor importance, yet the possible magnification of this danger and resultant government interference makes the elimination of lead desirable. Leadless enamels also permit the production of pure white and creamy white colors of absolute uniformity where sodium antimonate is used as an opacifying agent. It takes greater skill and better understanding of enamel composition to compound a good leadless enamel than a lead-bearing one. When melted, enamel glasses, aside from the opacifier, are true solutions. Any crystallization on cooling produces mat surfaces instead of bright surfaces. Crystallization is prevented by rapid cooling, by using compounds which increase the viscosity of the glass at the crystallizing temperatures, and by using compounds which crystallize at temperatures at which the viscosity of the enamel glass is high. Boric oxide is in the first class and lead oxide in the second. In leadless enamels, when lead is replaced by boric oxide, decrease in thermal expansion due to this change is prevented by increasing the sodium oxide until crystallization of sodium compounds becomes imminent when recourse is had to zinc and barium oxides. S. illustrates these principles by giving typical enamel compositions and a list of the factors for calculating coefficient of expansion which were used. The deficiencies of the latter are pointed out. For further articles see *Ceram. Abs.*, **4** [3], 59, 60, 61; [12], 331, 332 (1925); and **5** [5], 42 (1926). (*Ceram. Abs.*, **6**, 567 (1927).)

Staley, H. F.

GROUND-COAT ENAMELS FOR CAST IRON. *Jour. Amer. Ceram. Soc.*, **1**, 99 (1918).—Discussion of work done on seven ground-coat formulas. No conclusions given.

Raw batch	1	2	3	4	5	6	7 (1)	7 (2)
Flint	350	675	680					125
Borax	185	390	170	375	335	390	115	75
Sodium nitrate	35	35	50		30	30	20	15
Red lead	41	52.5	170	41	85	100	125	82
Cobalt oxide		3	0.8		2.7			
Potassium feldspar				435			300	
Feldspar						200		
Sand				275	685	200		
Magnesium carbonate						10		
Additions:								
Flint	345							
Clay	180	60	51	57	48	325	75	
Cobalt oxide				3.0		1		
Magnesium carbonate					3			
Flint							75	
Feldspar							120	
Flint equivalent	869	736	735	733	734	732	658	

Formulas:

No. 1

$$\left.\begin{matrix}0.785\ Na_2O \\ 0.215\ PbO\end{matrix}\right\} 0.807\ Al_2O_3 \left\{\begin{matrix}14.743\ SiO_2 \\ 1.103\ B_2O_3\end{matrix}\right.$$

No. 2

$$\left.\begin{matrix}0.810\ Na_2O \\ 0.165\ PbO \\ 0.025\ CoO\end{matrix}\right\} 0.158\ Al_2O_3 \left\{\begin{matrix}7.705\ SiO_2 \\ 1.342\ B_2O_3\end{matrix}\right.$$

No 3

$$\left.\begin{matrix}0.448\ Na_2O \\ 0.485\ PbO \\ 0.067\ CoO\end{matrix}\right\} 0.121\ Al_2O_3 \left\{\begin{matrix}7.102\ SiO_2 \\ 0.539\ B_2O_3\end{matrix}\right.$$

No. 4

$$\left.\begin{matrix}0.392\ K_2O \\ 0.493\ Na_2O \\ 0.095\ PbO \\ 0.020\ CoO\end{matrix}\right\} 0.507 Al_2O_3 \left\{\begin{matrix}4.884\ SiO_2 \\ 0.985\ B_2O_3\end{matrix}\right.$$

No. 5

$$\left.\begin{matrix}0.115\ K_2O \\ 0.646\ Na_2O \\ 0.021\ MgO \\ 0.203\ PbO \\ 0.015\ CoO\end{matrix}\right\} 0.224\ Al_2O_3 \left\{\begin{matrix}6.827\ SiO_2 \\ 1.033\ B_2O_3\end{matrix}\right.$$

No. 6

$$\left.\begin{matrix}0.167\ K_2O \\ 0.553\ Na_2O \\ 0.056\ MgO \\ 0.219\ PbO \\ 0.005\ CoO\end{matrix}\right\} 0.758\ Al_2O_3 \left\{\begin{matrix}3.72\ SiO_2 \\ 0.95\ B_2O_3\end{matrix}\right.$$

No. 7

$$\left.\begin{matrix}0.31\ K_2O \\ 0.29\ Na_2O \\ 0.40\ PbO\end{matrix}\right\} 0.428\ Al_2O_3 \left\{\begin{matrix}3.444\ SiO_2 \\ 0.404\ B_2O_3\end{matrix}\right.$$

This material is also contained in Bureau of Stand., *Tech. Paper*, No. 142. (Discussion by R. D. Landrum and E. P. Poste.) (*Chem. Abs.*, **12**, 2117 (1918); *Chem. and Ind.*, **38A**, 15 (1919).)

Staley, H. F.

PREPARATION AND APPLICATION OF ENAMELS FOR CAST IRON. *Jour. Amer. Ceram. Soc.*, **1**, 534 (1918).—Complete description of above processes. This material is also contained in Bureau of Stand., *Tech. Paper*, No. 142 (see above abstract). (*Chem. Abs.*, **13**, 253 (1919).)

Staley, H. F.

CONTROL OF THE LUSTER OF ENAMELS. *Jour. Amer. Ceram. Soc.*, **1**, 640 (1918).—Effect of viscosity, concentration, enameling technique, sulphur compounds are discussed. Brilliance of a glass is measured by its index of refraction. Effect of various fluxing oxides.

Constant portion raw			Melted percentages
		Silica	26.5
		Alumina	7.5
Potash feldspar	41.0	Potassium oxide	7.0
Borax	24.6	Boric oxide	9.0
Sodium nitrate	2.7	Sodium oxide	5.0
Cryolite	12.0	Aluminum fluoride	4.8
Tin oxide	8.0	Sodium fluoride	7.2
		Tin oxide	8.0
		Constant	75.0
		Variable	25.0

The composition of the 25% variable is shown below with the luster of the resultant enamel.

No.	Na_2O from soda ash	BaO from $BaCO_3$	CaO from $CaCO_3$	ZnO from zinc oxide	PbO from red lead	B_2O_3 from boric acid	Luster
1	25						Mat
2		25					Semimat
3			25				Not melted
4				25			Mat
5					25		Bright
6						25	Bright
7	12.5	12.5					Semimat
8	12.5			12.5			Mat
9	12.5					12.5	Semimat
10		12.5		12.5			Semimat
11		12.5				12.5	Bright
12				12.5		12.5	Bright
13	8.33	8.33		8.33			Oily
14		8.33		8.33		8.33	Bright
15	5.00	8.33		8.33	3.33		Bright
16	5.00	8.33		8.33		3.33	Bright

(Discussion by E. P. POSTE.) (*Chem. Abs.*, **13**, 775 (1919); *Chem. and Ind.*, **38A**, 140 (1919).)

Staley, H. F.

ENAMELS FOR CAST IRON. *Jour. Amer. Ceram. Soc.*, **1**, 703 (1918).—Discussion with tables for tin enamel composition and antimony enamel composition. Types of powdered enamel containing tin oxide to be applied to cast iron. (1) leadless, (2) low lead, and (3) high lead types.

TIN ENAMEL FORMULAS

(Raw batch for 1000 pounds melted)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Potash feldspar	340	410	380	400	380	380	380
Clay	55						
Sodium nitrate	5.5	30		30	25	30	30
Soda ash	21		30	90	50	30	30
Borax	555	240	225	225	165	215	215
Cryolite	110	120	10	40		30	
Fluorspar	5.5		85	85	120	50	50
Ammonium carbonate	8		1				
Magnesium carbonate	5.5						
Tin oxide	188.6	83	92	94	85	90	90
Boric oxide		220					
Zinc oxide		125	108	108	60	105	50
Quartz			15				
Potassium nitrate			60				
Potassium carbonate			30				

TIN ENAMEL FORMULAS (*continued*)

(Raw batch for 1000 pounds melted)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Red lead			82	94	175	168	255
Sodium silico-fluoride			40				
Manganese dioxide			1				
Arsenic oxide			6				
Barium carbonate					75	50	50
	1294.1	1228	1165	1166	1135	1148	1150

No. 1 published by Dr. Julius Grünwald (*Stahl u. Eisen*, **30**, p. 1204), who has written extensively on German enameling practice, is an example of the leadless type.

No. 2 conforms more nearly to American ideas of what a leadless enamel high in boric oxide should be.

No. 3 old formula for low lead type of enamel.

No. 4 modern derivative of No. 3.

Nos. 5, 6, 7, typical formulas for powdered enamel for cast iron of the high-lead type.

Enamels for cast iron using sodium metantimonate as an opacifying agent may be divided into three types: (1) leadless, (2) low lead, and (3) medium lead.

ANTIMONY ENAMEL FORMULAS

(Raw batch for 1000 pounds melted)

	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Potash feldspar	390	390	390	375	410	410	410	400
Sodium nitrate	35	35	35	25	70	70	90	75
Borax	350	300	250	275	350	300	240	230
Barium carbonate	80	80	70	100	80	75	80	80
Zinc oxide	140	110	85	70	140	100	100	92
Calcium carbonate	30	30	30		30	30	30	25
Fluorspar	73	73		100	60	73	45	55
Sodium antimonate	120	120	120	110				
Soda ash		45	55	25		25	30	20
Red lead		31	85	102		46	82	117
Calcium fluoride			73					
Cryolite					40	40	45	45
Antimony oxide					60	60	64	58
	1218	1214	1193	1182	1240	1229	1216	1197

The essential difference between sodium metantimonate enamel compositions and those in which oxide of antimony is used as the chief opacifier is that the latter contain much larger amounts of sodium nitrate. Corresponding reduction is made in other sodium compounds so that the total sodium oxide content remains about the same.

No. 8, typical example of leadless type.

No. 9, typical example of low lead type.

Nos. 10, 11, typical example of medium lead type.

Nos. 12, 13, 14, 15, typical example of enamels using antimony oxide.

(*Chem. and Ind.*, **38A**, 176 (1919); *Chem. Abs.*, **13**, 1000 (1919).)

Staley, H. F.

RELATION OF COMPOSITION TO SOLUBILITY OF ENAMELS IN ACIDS. *Jour. Amer. Ceram. Soc.*, **4**, 703 (1921).—Review of literature: *Trans. Amer. Ceram. Soc.*, **11**, 320–41; **12**, 463–94; **13**, 94–501; **14**, 489–509; **17**, 137–49; **18**, 762–66; Bur. Stand., *Tech. Paper*, No. 165, pp. 81–85; *Jour. Amer. Ceram. Soc.*, **1**, 422–28; **2**, 32–43; **3**, 560–67. (1) When substituted one for another, in each case in equal percentage

amounts, various oxides and minerals increased the resistance of various enamels to the action of boiling 20% hydrochloric acid in the following order of effectiveness: Al_2O_3, cryolite, Na_2O, PbO, BaO, Li_2O, MgO, CaF_2, ZnO, SrO, CaO, B_2O_3. The first five mentioned were especially effective. The remainder are undesirable materials from the standpoint of acid resistance. (2) The relative effects of the materials were the same for various base enamel compositions. (3) ZrO_2 and TiO_2, when substituted for small amounts of SiO_2, increased the resistance of various enamels to attack by acid, ZrO_2 being most effective in this respect. The favorable action of ZrO_2 is offset by a tendency to produce excessive chipping. Rutile gives less chipping than either zirconia or silica and greater acid resistance than silica. (4) Enamels 2, 17, 19, 26, 27, and 33 of Table I showed resistance to action of acid equivalent to that of the original composition based on the analysis of a French acid-resisting enamel. By use of the data developed in this investigation other highly acid-resisting compositions can readily be formulated.

TABLE I

COMPOSITION IN PERCENTAGES

No.	SiO_2	B_2O_3	Na_2O		Hours endurance*
2	68	7	19	6 ZnO	1000+
17	60	7	19	14 BaO	1000+
19	60	7	19	14 PbO	1000+
26	60	7	12	14 PbO 7 BaO	1000+
27	60	7	12	7 PbO 14 BaO	1000+

* Results of test with boiling 20% hydrochloric acid. (*Chem. Abs.*, **16**, 323 (1922); *Chem. and Ind.*, **40A**, 892 (1921).)

Staley, H. F.

DEVELOPMENTS IN ENAMELING TECHNOLOGY DURING PAST TWENTY-FIVE YEARS. *Jour. Amer. Ceram. Soc.*, **6**, 240 (1923).—Most marked achievements in enameling technology during the last quarter of a century are listed as: (1) invention of the automatic dredge for dry coat enameling; (2) introduction of machine molding of bathtubs; (3) development of the use of antimony compounds in dry coat enamels; (4) development of decorative enameling of cast iron by the wet process; (5) formation of the Enamel Division of the AMERICAN CERAMIC SOCIETY; (6) coöperative investigation of fishscaling in enamels on sheet steel conducted by the Enamel Division of the AMERICAN CERAMIC SOCIETY and the U. S. Bureau of Standards.

Staley, H. F.

SUGGESTIONS FOR DEVELOPMENT IN ENAMELING TECHNOLOGY. *Jour. Amer. Ceram. Soc.*, **7**, 719 (1924).—The more general use of melted weights in representing enamel compositions is suggested for development in enamel technology; the use of coefficient of thermal expansion factors; improvement in the mechanical properties of enamel glasses by increasing the percentages of zinc oxide, boric oxide, and titanium oxide, and by the use of thinner coatings; the widening of the heat range of ground-coat enamel compositions by the use of more complex compositions than are now employed; and finally, the more careful control of variation in the composition of the feldspars used in making enamels. (*Chem. Abs.*, **18**, 3461 (1924).)

Staley, H. F.

THEORY OF CLEANING SHEET IRON AND STEEL FOR ENAMELING PURPOSES. *Jour. Amer. Ceram. Soc.*, **9**, 593 (1926).—Cleaning may be done by sandblasting, heating, use of solvents, or use of alkaline solutions. Of these methods, heating and use of alkaline solutions are important at present. In cleaning by heating the best results

are obtained when the articles are first dipped in a solution of acid heated uniformly to the lowest temperature that will cause the oils and greases to be fired off and cooled slowly, both heating and cooling being done with the admission of as little air as possible. In cleaning by the use of alkaline solutions, saponifiable oils are removed by the formation of soaps and the subsequent solution of these; nonsaponifiable oils are removed by emulsification. Efficient cleaning depends primarily on the choice of cutting and drawing oils so as to have present a proper ratio of saponifiable and nonsaponifiable oils. The cleaning solution must vary in composition according to the kinds and amounts of oils to be removed. (*Chem. Abs.*, **21**, 164 (1927); *Ceram. Abs.*, **5**, 343 (1926); *Enamelist*, **4** [1], 49 (1926).)

Staley, H. F.

THEORY OF PICKLING OF SHEET IRON AND STEEL FOR ENAMELING PURPOSES. *Jour. Amer. Ceram. Soc.*, **9**, 787 (1926).—The fundamental principle of efficient pickling is that it does not depend on the solution of a large amount of metal but on the solution of a thin layer of metal directly beneath the scale, rapidly and with copious evolution of hydrogen. The activity of an acid solution depends on the amount of acid present, the fraction of the acid that is ionized, and on the speed with which the ions move. Since the electrical conductivity of an acid solution is a measure of both the hydrogen-ion concentration and the speed at which the ions move, the electrical conductivities of a series of acid solutions indicate the relative activities of the various solutions. The most effective concentrations of acid lie between 15 and 20%. Heating acid solutions reduces their viscosity and renders the particles more mobile, thus increasing the activity of the solutions. Sulphuric acid is cheaper in first cost than hydrochloric acid, but the latter acts more rapidly and the pickling is completed with less solution of iron. Additions of small amounts of common salt (sodium chloride) have a marked effect on increasing the rate of pickling of sulphuric acid baths. This is due to the formation of a corresponding amount of hydrochloric acid. The chief action of addition agents is to reduce the amount of acid vapor in the fumes from pickling vats and thus permit the use of highly efficient concentrations of acid (between 15 and 20%). Hydrogen absorbed by metals during pickling may be largely removed by immersing the metal in boiling water for a few minutes. (*Ceram. Abs.*, **6**, 50 (1927); *Chem. Abs.*, **21**, 635 (1927); *Chem. and Ind.*, **46B**, 751 (1927).)

Staley, H. F.

MANUFACTURE OF ENAMELED IRON SANITARY WARE. *Trans. Amer. Ceram. Soc.*, **8**, 172 (1906).—First utilitarian enamelwares were cooking utensils. These were manufactured in England by Cook Bros. in 1825. This article gives a general description of the process of enameling bathtubs. No compositions are given. (*Chem. Abs.*, **1**, 346 (1907).)

Staley, H. F.

COMPOUNDING OF FRITS. *Trans. Amer. Ceram. Soc.*, **10**, 113 (1908).—Use feldspar as foundation of frit; avoid clay; flint increases fusibility rapidly; Al_2O_3 quite refractory, use feldspar; cryolite O.K.; alkalis readily fusible, alike in action, regardless of source; Ca, Mg, and Ba when introduced as fluoride, have the same effect as if introduced through feldspar, their fluxing action is lessened when introduced as carbonates or free; zinc and lead show no difference between the oxides and carbonates; fluorine reduces melting point, causes crazing and milky opacity, makes frit fluid; boric acid has same effect regardless of source. Proportioning of frit: Twice as much feldspar can be used when fritted, clay is cut down to what is needed to give the glass good floative qualities, and flint is omitted. It is safe to have the equivalent amount

of total alkalis equal to the equivalent of alumina in the final glaze, up to 0.4 equivalent. Alkaline earths are kept low unless introduced by feldspar. Zinc oxide seems an equally efficient flux with lead oxide. The latter need not exceed 0.25 equivalent. Al_2O_3 and SiO_2, mainly from feldspar, must be in large enough amounts to overcome solubility of the fluxes and to prevent crazing. Boric acid is an available flux to be used as sparingly as possible on account of its cost and tendency to produce crazing, a last resort to increase fusibility. If it is desired to produce an enamel for metals that must melt down in a very few minutes, practically all of the material must be fritted. If a glaze is being made for ware that must be in a kiln for a considerable length of time, a good share of the material must be raw so as to get a slow and steady fusion and a rather viscous glaze. The raw and fritted part of the glaze should not be too far apart in fusion point or the soft portion is liable to suffer severely from volatilization. (*Chem. Abs.*, **2**, 3392 (1908).)

Staley, H. F.

CONTRACTION OF GLAZES AND GLASSES ON SOLIDIFYING AS A CAUSE OF CRAZING. *Trans. Amer. Ceram. Soc.*, **12**, 322 (1910).—It has long been customary to attribute all crazing to the glaze having a higher coefficient of thermal expansion than the body. Hovestadt's measurement of the effect of different fluxes on the coefficient of expansion of glass arranges them in a different order from that of Seger showing their tendency to cause crazing. While manufacturing enameled iron sanitary ware, S. found Seger's rule to hold for that class of work as well as pottery.

As it cools down, the iron loses its redness and the enamel becomes more and more viscous. Just as the enamel is changing from a very viscous fluid to solid glass, a series of sharp crackling sounds are heard for a period of from 3 to 5 minutes. If these are especially loud, the piece will be found to be crazed when it is cool enough to examine; thousands of (or all?) pieces of enameled iron show faint crazes at this stage, which have entirely closed up by the time the ware has cooled to atmospheric temperatures.

Enameled ware crazes only at the time of manufacture, not subsequently. Barus says basalt contracts 3.5 to 4% in solidifying; Mallet, that plate glass (acid silicate) contracts 1.59%, and iron slags (basic silicate) 6.7%. Frits are cooled in a crucible. The sudden contraction in solidifying causes the crazing of enameled iron, and likely in many cases with other glazes. The same causes necessitate the annealing of glass. (Discussion by J. B. Shaw and R. Frink.) (*Chem. Abs.*, **5**, 169 (1911).)

Staley, H. F.

CALCULATIONS OF CERAMIC MIXTURES. *Trans. Amer. Ceram. Soc.*, **13**, 122 (1911).—The calculation of ceramic mixtures is discussed from five standpoints: (1) per cent amounts of raw materials, (2) empirical formulas, (3) "norms," (4) eutectics, and (5) empirical physical factors. (1) is the simplest and is useful when the number of ingredients is few and the variations small; (2) is simple and graphic but it can "lay no claim to scientific foundation;" it is "pseudochemistry" neglecting important physical and mineralogical differences, since it is based upon ultimate analysis of the batch; (3) is an adaptation[1] in which a norm is taken to be the mineral constitution of the rock magma as indicated by the composition of the minerals which crystallize out when the rock magma solidifies; "the use of norms is restricted to a narrow field and must at all times be more or less hypothetical," but it is held to be the only rational method of attack in some cases; (4) is at present merely suggestive; (5) is based on empirical

[1] Cross Iddings, *et al.*, Quantitative Classification of Igneous Rocks. (Univ. of Chicago Press.)

physical factors determined separately for each class of ceramic mixtures and is offered as being capable of giving the exact control of mixtures in actual factory practice. (Discussion by C. F. Binns, C. Stover, C. Kerr.) (*Chem. Abs.*, **6**, 142 (1912).)

Staley, H. F.

CAUSE AND CONTROL OF MOTTLING OF ENAMELS ON METAL. *Trans. Amer. Ceram. Soc.*, **13**, 489 (1911).—Conditions that may cause poor mottling may be any of the following: (1) the presence of scales of iron oxide on the ware, (2) too little hydrated ferrous oxide on the ware, (3) too much ferrous sulphate on the ware, (4) allowing the storage tank water to become alkaline, (5) allowing the enamel to become acid, and (6) too long and too hard firing. (*Chem. Abs.*, **5**, 3890 (1911).)

Staley, H. F.

RESISTANCE OF SHEET-STEEL ENAMELS TO SOLUTION BY ACETIC ACID OF VARIOUS STRENGTHS. *Trans. Amer. Ceram. Soc.*, **13**, 497 (1911).—Discussion of paper by R. D. Landrum. (See this *Bibliography*, p. 190.) S. mentions the following considerations which must be kept in mind in work of this kind: (1) In dilute acid solutions, the acid is more dissociated than in concentrated solutions. This will give more action in a given time per unit of acid and does not mean that the more highly ionized acid is capable of dissolving more enamel if the reactions are allowed to come to equilibrium. (2) Dilute acid solutions contain fewer units of acid. (3) Very highly concentrated acid solutions have little action. (4) The concentration of the acid solutions varied continuously as they were boiled, becoming more and more concentrated as the boiling progressed. Therefore, the more dilute the acid the longer the time in which active concentrations would be operating. It also follows from this that the slower the rate at which the acid is concentrated, the greater will be its solvent action.

Staley, H. F.

CONTROL OF FUSIBILITY IN ENAMELS. *Trans. Amer. Ceram. Soc.*, **13**, 502 (1911).—The following oxides have the same fluxing power, pound for pound: (1) Potassium oxide from soluble salts, sodium oxide from soluble salts, barium oxide from barium carbonate, zinc oxide, and lead oxide. (2) Taking the fluxing power of any one of the above oxides, *e.g.*, PbO as unity, it takes 0.8 lb. of either B_2O_3 or BaF_2 to give one unit of fluxing power, that is, these substances have a fluxing power factor of $1^1/_4$. (3) It takes 0.6 lb. of CaF_2 to give one unit of fluxing power, that is, CaF_2 has a fluxing power factor of $1^2/_3$. (4) Taking the power of an addition of 1 pound of dry ground flint as the unit of refractoriness, it takes $1^1/_2$ lbs. of the particular feldspar being used, or of bone ash, to give one unit of refractoriness; *i.e.*, this feldspar and bone ash have a refractoriness factor of $^2/_3$. (5) The full statement of the fusibility of an enamel is embodied in the following formula:*

Fluxes *A*		Refractories *B*
K_2O from soluble salts Na_2O from soluble salts BaO from $BaCO_3$ CaO from $CaCO_3$† ZnO PbO	× 1 =	Flint × 1 = Feldspar × *Y* = † Bone ash × $^2/_3$ = Sand × *Z* = †
B_2O_3, BaF_2	× $1^1/_4$	
CaF_2, Na_3AlF_6	× $1^2/_3$	

Sum of fluxing units (*A*) over sum of refractory units (*B*) = fluidity ratio.
† For small amounts only.

* *Y* and *Z* determined for each feldspar and sand.

Molecular Formula			Fusibility Formula	
0.209 K_2O			57 K_2O	
0.121 Na_2O			24 Na_2O	
0.001 MgO			15 CaO	
0.269 CaO	0.132 Al_2O_3	0.07 SiO_2	10 BaO	$\times 1 = 316$
0.083 BaO		0.27 Fl_2	50 ZnO	
0.147 ZnO		0.19 B_2O_3	160 PbO	
0.170 PbO			56 B_2O_3	
			50 BaF_2	$\times 1\frac{1}{4} = 132.5$
			65 CaF_2	
			20 Na_3AlF_6	$\times 1\frac{2}{3} = \frac{141.66}{590}$

OR = 1:1.94
SnO_2 as opacifier not included

50 flint × 1 = 50
311 feldspar × $\frac{2}{3}$ = 207.33
36 bone ash × $\frac{2}{3}$ = 24.0
281

Fluidity ratio = 590/281 = 2.10:1

MELTED WEIGHTS FOR THIS ENAMEL

Feldspar	311.0	K_2O from KNO_3	28.0
SiO_2 from flint	50.0	BaO from $BaCO_3$	10.0
CaF_2	65.0	CaO from $CaCO_3$	15.0
Na_3AlF_6	20.0	ZnO	50.0
BaF_2	50.0	PbO from Pb_3O_4	160.0
B_2O_3 from borax	56.0	Bone ash	36.0
Na_2O from borax	24.0	SnO_2	85.0
K_2O from K_2CO_3	29.0	MnO_2	1.2
			990.0

(*Chem. Abs.*, **6**, 142 (1912).)

Staley, H. F.

CAUSE AND CONTROL OF CRAZING IN ENAMELS ON CAST IRON. *Trans. Amer. Ceram. Soc.*, **14**, 516 (1912).—*Control of general crazing:* (1) When general crazing occurs in a fusible enamel, increase feldspar. When general shivering occurs in a refractory enamel, decrease the feldspar. (2) When general crazing occurs in a refractory enamel, increase the boric acid. (3) In all cases of general crazing or shivering, and especially in cases where these defects occur together, see to it that the fusibility of the ground coat and the enamel properly conform. (4) Have the enamel applied to the ware in as thin and as uniform a coat as possible. *Causes of general crazing and shivering:* (1*a*) difference in coefficient of contraction and expansion of the iron and the enamel; (1*b*) strength of enamel; (1*c*) ductility of enamel. (2) Unequal cooling. Article also gives special cases of crazing and possible remedies. Discussion of this paper by Landrum, Pence, Bruner, and Blackham. (*Chem. Abs.*, **7**, 230 (1913); *Chem. and Ind.*, **31**, 1129 (1912).)

Staley, H. F.

RELATIVE ACTION OF ACIDS ON ENAMEL. *Trans. Amer. Ceram. Soc.*, **17**, 144 (1915).—Discussion of paper by E. P. Poste. Curves are given showing the conductivity of nitric, sulphuric, hydrochloric, and acetic acids.

Staley, H. F.

ANTIMONY COMPOUNDS AS OPACIFIERS. *Trans. Amer. Ceram. Soc.*, **17**, 173 (1915).—*Gloss:* Oxide of antimony enamels of good gloss can be made from three types of formulas: (1) high boric oxide, no lead type; (2) medium boric oxide, no lead type; (3) low boric oxide, lead-bearing type. Oxide of antimony enamels contain 3-color components; a tan probably due to sulphur and fading as the smelting continues; a yellow due to lead oxide and persistent; and a blue, due to a combination of antimony

oxide, boric oxide, calcium and fluorine, which grows more intense as smelting continues. Opaque whites are produced by controlling the heat treatment and composition so that the tan and yellow are neutralized by blue. The dark specks in oxide of antimony enamels are due to contamination with organic or metallic dirt after the enamel is smelted. The remedy is extreme cleanliness. Discussion by A. Silverman. (*Chem. and Ind.*, **36**, 879 (1917).)

Staley, H. F.

MATERIALS AND METHODS IN MANUFACTURE OF ENAMELED CAST-IRON WARE. U. S. Bur. Stand., *Tech. Paper*, No. 142.—This is a comprehensive treatise dealing with the various phases of the technology of manufacturing enameled cast-iron ware. It is the first publication dealing fully with this subject in any language. The coating of cast iron with white vitreous enamels by the American or dry-powder process is discussed. In this method, the thoroughly cleaned castings are painted with a suspension in water of powdered glass, clay, etc. This suspension is known as the ground coat. The castings are then heated until the ground coat is thoroughly fused, forming an extremely thin layer of transparent glass on the castings. The ware is then withdrawn from a furnace and immediately coated by means of long-handled sieves with a layer of white, opaque, powdered glass, known as the cover-coat enamel. Next the castings are returned to the furnace, and in a couple of minutes the cover-coat enamel fuses to a smooth layer. Two such layers of cover-coat enamel are usually applied, giving a total thickness of $^1/_{32}$ to $^1/_{16}$ of an inch. The enameling of cast iron with wet cover-coat enamels is not discussed. The preparation and testing of the various chemicals and minerals used in compounding enamels and the effect of these on the physical and chemical properties of enamels are dealt with. The methods employed in making and cleaning the castings are described in detail beginning with construction of patterns and ending with sandblasting and polishing. The methods and equipment including furnaces, used in preparing enamels and applying them to castings, are covered in two sections. The control of the luster of enamels, the cause and control of crazing, and the methods to be used in avoiding blisters, pinholes, and other minor defects are given. Typical formulas are given for ground-coat enamels, cover-coat enamels containing oxide of tin, and for those containing antimony compounds as the opacifying agent. These formulas are each stated in terms of raw batch for 1000 pounds melted enamel, of percentage composition, and of empirical formula. The calculations involved in arriving at each form of expression are explained in detail. (*Jour. Amer. Ceram. Soc.* (Abs.), **3**, 82 (1920); *Chem. Abs.*, **14**, 1017 (1920).)

***Staley, H. F.**

MODIFICATION OF MOLECULAR FORMULA FOR GLAZE AND ENAMEL CALCULATIONS. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 38).

EFFECT OF SOURCES OF PIG IRON UPON ENAMELING OF CAST IRON. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 40).

TRANSPARENT ENAMELS. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 41).

ZIRCONIA IN ENAMELS. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 41).

PLASTICITY. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 42).

PLASTIC PROPERTIES OF ENAMEL SLIP. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 44).

FREE QUARTZ IN FELDSPAR. (Discussion.) See *Ceramist* (this *Bibliography*, p. 62).

REFRACTORY VALUE OF ENAMELS. (Discussion.) See *Ceramist* (this *Bibliography*, p. 62).

EFFECT OF VARIATION IN THE COMPOSITION OF GROUND COATS FOR SHEET-IRON ENAMELS. See Danielson, R. R. (this *Bibliography*, p. 83).

FUNDS SECURED FOR ENAMELING RESEARCH. See *Ceramist* (this *Bibliography*, p. 62).

Staley, H. F., and Fisher, Geo. P.

LEADLESS ENAMELS. *Trans. Amer. Ceram. Soc.*, **15**, 620 (1913).—(1) Four leadless enamels of good working properties have been produced. (2) In enamels of this type, crazing and loss of gloss are liable to occur when the fluorides exceed 15% of the melted weight of glass. (3) Enamels of the type usually used for sheet steel are too refractory and too high in fluorides to be used successfully on cast iron. (4) It is not possible in all cases to stop crazing by decreasing the fusibility of an enamel. (5) All the fluxing oxides in common use with the exception of PbO and B_2O_3 give a mat finish when used in excessive amounts. Part I. Elimination of lead oxide. Best in this series:

	Raw Batch Weights	
Feldspar	422.0	436.0
CaF_2	122.5	154.5
Borax	151.0	151.0
Soda	80.84	107.0
$NaNO_3$	27.4	27.4
$BaCO_3$	90.3	90.3
$CaCO_3$	26.85	
ZnO	150.0	110.0
SnO_2	83.0	83.0

Part II. The conversion of a sheet steel enamel (free from lead and zinc oxides) into a cast-iron enamel. Best formulas from series of replacement tests were:

	Raw Batch Weights	
Feldspar	410.0	410.0
Cryolite	120.0	120.0
Borax	241.0	241.0
$NaNO_3$	27.0	27.0
SnO_2	80.0	80.0
$B_2O_3 \cdot 3H_2O$	443.0	222.0
ZnO		125.0

Discussion by F. C. Flint. (*Chem. Abs.*, **8**, 805 (1914); *Chem. and Ind.*, **33**, 80 (1914).)

Statutory Rules and Orders, 1908, No. 1258, Dec. 18, 1908 (British).

HOME OFFICE REGULATIONS FOR VITREOUS ENAMELING METAL OR GLASS.—The definitions for terms involved and the duties of the employer and persons employed, are given. (*Chem. and Ind.*, **28**, 91 (1909).)

***Stenotype Co.**

ENAMELING OVENS. See *Amer. Machinist* (this *Bibliography*, p. 5).

***Stephenson, H. H.**

EXACT NOTIONS OF FLUORINE ENAMELS. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 42).

Stewart, J.

PLASTICITY OF CLAY. *Ind. Eng. Chem.*, **5**, 421 (1913).—Plasticity of clay is due to the presence of an organic albuminous compound or such compounds. (*Chem. Abs.*, **7**, 2459 (1913).)

Stewart, W. C.

ENAMELING. U. S. Pat. 529,670, Nov. 20, 1894.—An improved process of enameling articles, which consists in applying a thin coating so as to cover as much of the article as is to be enameled; then, while the thin coating is still wet, in applying a second partial coating of a contrasting color in the form of spots or blotches, the partial coating being thicker and heavier than the thin coating, whereby the spots or blotches will displace the thin coating, then in drying the article, and finally in firing it.

Stewart, W. C.

ENAMELING SHEET METALWARE. See V. Dubois (this *Bibliography*, p. 98).

Stief, W. C., and Hemsteger, S. E.

MODERN FRIT FURNACE. *Bull. Amer. Ceram. Soc.*, **5**, 473 (1926).—A rotary smelting furnace of 1200-pound capacity, heated with oil, and equipment required to operate it are described. The operation and method of smelting are discussed in detail. The cost of producing frit by this method is very low in comparison to the old sagger method and the frit has the outstanding qualities of (1) uniformity of composition and (2) being capable of grinding easily. (*Ceram. Abs.*, **6**, 68 (1927).)

Stine, E. L.

HISTORY OF ENAMEL ARTS AND ENAMEL ORNAMENTATION. *Enamelist*, **1** [1], 3 (1923).—The enameling of metals is of great antiquity, and the art has probably come down from the Scythians who introduced it into China at the time of Emperor Thai-coonti. The Egyptians, Phoenicians, and Assyrians had already made enamel jewelry, but during the period of classical culture the art remained Oriental, since neither the Greeks nor Romans accomplished anything noteworthy in this direction. The principal producing countries were the Black Sea territories and North India from whence the Byzantines transferred the art into Europe in the 11th Century. The industry flourished especially in Italy, France, and Central Germany. In 1866 artistic enamel works were found among the ruins of Pinguentun. To the 11th Century also belong the eight enameled gold plates which were discovered in 1860 while tilling a field in Hungary. The Byzantine enamelers were familiar with white, brown, blue, green, and black. About the time of Nicholas of Verdun the development of a specific French enamel art took place.

Stine, E. L.

HISTORY OF ENAMELING. *Enamelist*, **1** [2], 4 (1923).—The early history of the enameling industry in the United States. First ware was introduced into this country by Morris Stransky as agent for the largest European manufacturers. Lalance and Grosjean Mfg. Company of Woodhaven, L. I., and the St. Louis Stamping Company were the pioneer enamelers of this country.

Stine, E. L.

SIGN WORK. *Enamelist*, **2** [2], 9 (1924).—The sheets are enameled in ground coat with two coats of white and fired. Next is applied the colored enamel which is dried but not yet fired. The stencil is laid upon this sheet and with a flat brush the exposed enamel is brushed away, thus leaving the letters with the ties on and with the second stencil these ties are brushed away and the sign is finished.

Stine, E. L.

STENCIL CUTTING. *Enamelist*, **2** [3], 30 (1924).—Brass stencils are cut with a hammer and chisel. The rough edges are then filed off. For zinc stencils, the sheet is covered with asphaltum. A layer of thin lead foil is placed upon the asphaltum. The stencil is cut through the lead and asphaltum layers. Muriatic acid is used to dissolve the zinc in the exposed parts. Oil board stencils are cut out with a sharp knife.

Stockstrom, A.

NEW TYPE OF GAS-FIRED VITREOUS ENAMELING FURNACE. (Discussion.) *Bull. Amer. Ceram. Soc.*, **1**, 238 (1922).—After three months of operation no fault was found with this gas-enameling furnace. The quality of ware has improved, costs of production have decreased, and the service from the enameling department to the assembling departments has greatly improved. Some advantages over coal-fired muffle furnaces are: (1) ease of temperature control, (2) flexibility of temperature control, and (3) freedom from breakdowns and interruption of production. Cost data are given as follows: Artificial gas of 580 B.t.u. was used, at $0.85 per 1000 cu. ft. Gas consumption was 1640 cu. ft. per hr., or an hourly gas cost of $1.40. Ware consisting of flat sheet-iron parts ranging from 24 to 18 gage, gave an hourly production figure of 270 sq. ft. The fuel cost on the above basis is $0.52 per 100 sq. ft. of ware fired. The exact saving as compared to coal furnaces cannot be determined as the life of the gas furnace is not known. From all indications the furnace will need no repairs for some time.

***Stone, J. & Co.**

ENAMELING OR GLAZING METAL ARTICLES. See Lambert, W. (this *Bibliography*, p. 184).

Strauss, B.

RUST-RESISTING STEEL V2A, AND APPARATUS CONSTRUCTED THEREOF. *Krupp. Monatsh.*, **6**, 149 (1925).—This steel contains 20% chromium, 7% nickel, and 0.2% carbon, photomicrographic examination showing a mixed crystal-austenite structure in which carbon, chromium, and nickel are completely dissolved. V2A not only possesses good mechanical strength, 70 to 80 kg. per sq. mm., 50% elongation, but is inert to chemical action. The weight in grams per hour per square mm. of metal dissolved in various reagents at temperatures from 20 to 150° is as follows: HNO_3 concentrated at 20° 0.00 g., boiling 0.02 g., HNO_3 + 5% H_2SO_4 boiling 0.59 g.; H_2SO_4 at 20°; 10%, 0.07 g.; 30%, 0.16 g.; 66%, 0.001 g.; 98%, 0.012 g.; 20% boiling, 36.0 g.; 58% H_2SO_4 + 40% HNO_3 + 2% H_2O at 20°, 0.00 g.; at 60°, 0.05 g.; at 100°, 0.70 g.; at 110°, 7.6 g.; 80% H_3PO_4 at 115°, 134.3 g.; 50% KOH solution boiling, 0.40 g.; KOH at 360°, 3.5 g.; at 600°, 37.9 g.; $CuCl_2$ solution boiling 1–1, 464.0 g.; $FeCl_3$ solution 1–1, 101.0 g.; at 50° other salts and acids only slight action. V2A has a specific gravity 7.86, specific heat 0.118, thermal conductivity 0.04, coefficient of expansion: 0–100°, 16×10^{-6}; 0 to 600°, 18×10^{-6}; 0 to 1000°, 20×10^{-6}, melting point, 1400°. This steel permits of autogenous welding and can be cold-drawn or stamped, permitting its use in the manufacture of many types of equipment, photographs of which are shown. Special heat treatment is needed, the temperature being raised to 1170° and the alloy then quickly cooled. For acids which attack V2A, two special alloys are made, V4A and V6A, containing Mo and Cu. V2A also finds application in the canning industry. (*Ceram. Abs.*, **5**, 14 (1926).)

Strong, Thomas L.

APPARATUS FOR DRYING ENAMELED WARE. U. S. Pat. 771,507, Oct. 4, 1904.—The combination of a furnace having a single door for the admission and withdrawal

of the ware, a support in front of the door, means directly above the furnace door for collecting the heat emanating from the hot ware resting on support, and means for transferring the heat to drying room.

Sugie, S., and the Osaka Ind. Lab.

RED ENAMEL PIGMENTS. Japanese Pat. 38,426, April 13, 1921.—An intimate mixture of CdS 86% and Se 14% or a mixture of Na_2SO_3 55%, $CdSO_4$ 35%, S 7% and Se 3% is heated in a crucible at 500 to 700° to form Cd_3SeS_2. (*Chem. Abs.*, **16,** 1304 (1922); *Chem. and Ind.*, **40A,** 390 (1921).)

Summers, J. A.

COMMERCIAL PHOTOMETRY. See Powell, A. L. (this *Bibliography*, p. 249).

***Superior Enamel Products Co.**

GOOD MIXING REDUCES SMELTING COST. See *Ceram. Ind.* (this *Bibliography*, p. 60).

Sussmann-Hellborn

MANUFACTURE OF ENAMEL. *Bayr. Gwbl.*, p. 107 (1876). (*Rep. der Tech. Lit.*, p. 54 (1876).)

Svagr, E.

ANTIMONY ENAMELS FOR COOKING UTENSILS. *Chem. Listy*, **20,** 21 (1926).—Enamels containing $NaSbO_3$ do not lose antimony by solution in any organic acid of the strength met with in foodstuffs. They may be subjected to prolonged use for cooking without ill effects. Antimonious compounds are more toxic. (*Ceram. Abs.*, **5,** 176 (1926); *Chem. and Ind.*, **45B,** 192 (1926).)

Sweely, B. T.

MICROSCOPIC STUDY OF GROUND-COAT AND COVER-ENAMEL REACTIONS. (Discussion.) *Bull. Amer. Ceram. Soc.*, **1,** 112 (1922).—Mr. Geisinger (see this *Bibliography*, p. 128) should be congratulated on the preparation of the data contained in his paper. Light steel, used for cooking ware, etc., usually will not fishscale badly after the second coat of enamel is applied, probably because sufficient strength is secured in the two coats to resist the stress set up by the contracting steel. Most of such ware being enameled on both sides, is further protected against failure in the characteristic fishscale form by the fact that after the second coat of enamel is applied, there are in reality four coats of enamel to resist the stress set up by the greater contraction of steel over enamel. Consequently failure or fishscale seldom occurs on such ware in the second coat. In enameling heavy plate, however, such as was used in this work, it was probable that fishscale would occur after the second coat was applied, as a very heavy steel was used, and the enamel applied to one side only, the finished piece having far from sufficient enamel to counteract the stress set up by the contracting steel. The work of Danielson and Souder (this *Bibliography*, p. 88), was done under an entirely different set of conditions. They were working with thin sheet, from 22-gage to 28-gage steel enameled on both sides, with but one coat of enamel, and the fishscale encountered in their work occurred in this one or first coat of enamel and not in a subsequent cover coat. It would be interesting to know whether G. has ever experienced fishscale to any great degree in his ground coats. S. has observed that bubble formation in ground-coat enamels is very prevalent, in fact under even a low power glass, most ground coats reveal a large number of minute bubbles, and it might well be that this bubble structure, or the lack of it, plays an important part in the fishscaling of first coat and grayware enamels under varying conditions.

Sweely, B. T.

BEST TYPE OF FURNACE FOR ENAMELING PLANTS. *Ceram. Ind.*, **3**, 34 (1924).—The lack of definite data as to (1) the best type of furnace, (2) most economical fuel, and (3) for a given location, the best type of construction for a given fuel, whether gas, coal, oil, or electricity. A study of furnace performance, conducted by a disinterested agency, is suggested as a means of solving the problem.

Sweely, B. T.

COMPOSITION OF ARSENIC ENAMELS FOR COPPER. *Jour. Amer. Ceram. Soc.*, **4**, 350 (1921).—The formula of a ground coat with which good results were secured on thin copper sheet is given below:

$$\left.\begin{matrix}0.15\ K_2O\\0.55\ Na_2O\\0.20\ CaO\\0.10\ BaO\end{matrix}\right\}0.15\ Al_2O_3\ \left\{\begin{matrix}1.8\ SiO_2\\0.4\ B_2O_3\end{matrix}\right.$$

	Equiv.	Batch wts.
Feldspar	0.15	83.5
Sodium nitrate	0.10	17.0
Soda ash	0.45	47.7
Whiting	0.20	20.0
Barium carbonate	0.10	19.7
Boric acid	0.40	49.6
Flint	0.90	54.0

Milled with 5% clay and 10% tin oxide

	Series I	Series II	Series III
Soda ash	55.2	55.2	13.8–96.6
Soda nitrate	17.0	17.0	17.0
Red lead	114	114	182.4–45.6
Arsenious oxide	19.8	19.8	19.8
Boric acid	18.6	0–49.6	18.6
Flint	108–132	108	132

Results of this investigation seem to indicate that with an arsenic content of 0.1 equivalent As_2O_3 in an enamel of this type applied by the dry method, the following relations hold true: (1) Increase of silica with RO, arsenic and boric acid constant, increases tendency of enamels to fracture, increases refractoriness, does not affect opacity except by dilution, and does not affect luster. (2) Increases of boric acid above 0.2 equivalents, with RO, arsenic and silica constant, causes enamels to become mat. Increase of boric acid decreases tendency toward fracturing, which is the converse of results obtained in Series I with increase of silica. (3) Increase of K_2O at expense of PbO with arsenic, boric acid, and silica constant, causes enamels to flow better, mature at a lower temperature, increases solubility, decreases tendency to fracture, and those enamels containing more than 0.6 equivalents KNaO mature to clear glass. (4) High lead enamels are very opaque but do not flow well and show an excessive attack of the copper. From the data at hand, S. feels justified in recommending the following limits in composition for enamels of this type.

Molecular Formula Limits

$$\left.\begin{matrix}0.3\text{–}0.6\ KNaO\\0.7\text{–}0.4\ PbO\end{matrix}\right\}\qquad\left\{\begin{matrix}1.3\text{–}1.8\ SiO_2\\0.0\text{–}0.2\ B_2O_3\\0.05\text{–}0.15\ As_2O_3\end{matrix}\right.$$

(*Chem. Abs.*, **15**, 4043 (1921); *Chem. and Ind.*, **40A**, 511 (1921).)

Sweely, B. T.

ACID RESISTANCE OF ENAMELED COOKING UTENSILS. *Jour. Amer. Ceram. Soc.*, **4**, 407 (1921).—Experiments with trial pieces with poured samples, and with enameled

ware of various manufacturers showed that the surface of the layer of enamel which is uppermost during firing and cooling is readily attacked by acid, thus indicating, apparently, that the more soluble materials tend to rise to the top of the melt. It is therefore recommended that enameled kitchen utensils be fired in an inverted position. In the discussion by B. A. Rice a series of similar experiments are described using small shallow cups. Quantitative tests failed to show any difference in acid resistance and it is suggested that results of S. were due to the nature of the gases in contact with the enamel surface or to volatilization. In his reply, S. accepts this explanation of his results. (*Chem. Abs.*, **15,** 4043 (1921); *Chem. and Ind.*, **40A,** 511 (1921).)

Sweely, B. T.

RELATION OF COMPOSITION TO THERMAL SHOCK IN STEEL ENAMELS. *Jour. Amer. Ceram. Soc.*, **5,** 263 (1922).—Practical experience has shown that resistance to thermal shock is greatest when the enamels are applied in thin coats. Considering the coefficients of enamels and steel, it would seem that if the coefficient of the finish enamel was lower than that of the steel and first coat, the stress set for any given temperature change should be smaller, and the probability of failure decreased. Further, since the adhesion of ground to steel is very much above the tensile strength of the glass itself, it would seem logical to increase the coefficient of expansion of the ground coat as much as possible, in order to have as much contraction as possible over the temperature interval occasioned by the loss of heat through the cover enamel when the piece is immersed in the cooling medium. Under these conditions, cover enamel and first coat should contract at a rate more nearly coincident and the stress set up by any sudden temperature change be decreased.

MELTED WEIGHTS

	Ground I	Ground II	White enamel
Feldspar	34.6	55	22.2
B_2O_3	13.85	5	9.8
Na_2O	15.5	10	8.23
Fluorspar	7.5	7.5	7.86
SiO_2	25.4		31.90
MnO_2	2.0		
NiO	0.5	0.5	
CoO	0.42		
Cryolite		12	18.0
BaO		10	
ZnO			2.0
Cubical coeff.	318×10^{-7}	432×10^{-7}	334×10^{-7}

This white enamel used on Ground I produces a ware of about the average resistance to temperature change. A piece of this ware placed over a Bunsen burner, heated to red heat, and quenched with water will spall off in one or two trials. The same enamel applied to Ground II and tested as above will withstand the test five or six times repeated without chipping or spalling off. (*Chem. Abs.*, **16,** 2763 (1922); *Chem. and Ind.*, **41A,** 465 (1922).)

Sweely, B. T.

OBSERVATIONS OF FISHSCALING OF GROUND-COAT ENAMELS. *Jour. Amer. Ceram. Soc.*, **5,** 618 (1922).—In order to see if fishscaling was due to compressive stress in the enamel, the following test was made. The enamel was removed from one side only of a piece of ware on the assumption that, if the enamel was in compression, the removal of it from one side of the steel should throw the entire stress, formerly taken by the inner and outer coats upon one coat and result in an exaggerated case of fishscale over

the area from which the one coat of enamel was removed. The enamel was removed by concentrated hydrochloric acid. On the trial so treated, the area of first coat removed on the inside is sharply defined by the fishscaled area on the outside of the piece. While there is evidence of fishscale at other points on both inside and outside of the basin, over the area defined by the dissolved inside first coat a pronounced case of fishscale has developed. In order to find if this result was in any way due to hydrogen penetration of the steel after the first coat was dissolved, and also whether a piece ground coated on one side only would develop the same result, a basin was coated on the outside only with the same enamel and the same acid test made as before. No fishscale developed over the area subjected to the acid treatment, nor is the piece at any point decidedly fishscaled. The following enamel was produced to have a coefficient of expansion high enough to eliminate compressive stress:

	Melted (%)
Feldspar	55.0
B_2O_3	5.0
Kryolith	12.0
Na_2O	10.0
CaF_2	7.5
BaO	10.0
CoO	0.5

The theoretical cubical coefficient of this enamel according to the factors given by Mayer and Havas is 432×10^{-7}. The figure given by Danielson and Souder for average steel is about 384×10^{-7}. If the above figures are true, the enamel should be in tension rather than compression and might craze rather than fishscale. Samples were coated with this enamel and treated with acid as before. There was no evidence of fishscale shown at any point on the piece. Further when applied in a rather heavy coat, and with the light falling at just the right angle, craze lines can be faintly seen, indicating that the assumptions made in compounding the enamel were at least partly correct. The commercial use of an enamel of this type is practically impossible. The very high content of fluxes of this enamel makes its heat range very short, and its use in the average plant is not feasible. Continued experiments along these lines by S. have seemed to indicate that under factory conditions any composition whose theoretical coefficients amount to approximately 400×10^{-7} will not fishscale. Discussions by Wiester, Geisinger, and Danielson. (*Chem. Abs.*, **16**, 4037 (1922); *Chem. and Ind.*, **41A**, 814 (1922).)

Sweely, B. T.

PRACTICAL CHEMICAL CONTROL OF PICKLING ROOM SOLUTIONS. *Jour. Amer. Ceram. Soc.*, **9**, 590 (1926).—This paper gives a brief outline of pickle-room practice and gives in detail a rapid method of titration of solutions by use of specially graduated cylinders and the addition of indicator to normal or fractionally normal solutions. The strength of solutions is recommended as follows:

Cleaning solution	3–5%
Sulphuric acid solution	$3^1/_2$–5%
No. 1 neutralizing bath	0.6–0.8%
No. 2 neutralizing bath	0.15–0.20%

(*Chem. Abs.*, **21**, 164 (1927); *Ceram. Abs.*, **5**, 343 (1926); *Enamelist*, **4** [2], 18 (1926).)

***Sweely, B. T.**

CONTROL OF ENAMEL FOR DIPPING WARE. See Fusselbaugh, R. R. (this *Bibliography*, p. 126).

PLASTICITY. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 42).

PLASTIC PROPERTIES OF ENAMEL SLIP. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 44).

RELATION BETWEEN THE COMPOSITION AND PROPERTIES OF ENAMELS FOR STEEL PLATE. See Danielson, R. R. (this *Bibliography*, p. 89).

Sweely, B. T., and Prince, E. S.

RELATION OF FINENESS OF GRINDING TO OPACITY IN WHITE ENAMELS. *Jour. Amer. Ceram. Soc.*, **5**, 855 (1922).—The problem of securing a uniform opacity by taking observations of smelting, testing of raw materials, etc., led to the conclusion that the most important process was the mill treatment given the mixture. A table showing screen analyses of white enamels is given. The conclusion drawn from the data obtained was that for this type of ware and under the factory conditions, best results were to be expected when the glass was milled to a fineness such that all would pass 100-mesh and from 5 to 10% be retained on 120-mesh. The results of this study were put into practice at once with good results, eliminating much variation in opacity and securing more consistent results on all ware. Discussion by Wells, E. P. Poste, and M. E. Manson. (*Chem. Abs.*, **17**, 456 (1923); *Chem. and Ind.*, **42A**, 97 (1923).)

Tafner, H.

FLUORITE AND ITS FUNCTION IN ENAMELS. *Sprechsaal*, **43**, 36 (1910).—Enamels containing calcium fluoride do not represent stable compounds as fluorine continues to be given off on heating. Fluorite melts between 1400 and 1600°. Its solubility in water is greater than is commonly assumed. (*Chem. Abs.*, **5**, 773 (1911); *Chem. and Ind.*, **29**, 213 (1910).)

Talley, R. E.

ELECTRIC ENAMELING FURNACE. U. S. Pat. 1,542,278, June 16, 1925.—An electric furnace having heating elements along the walls thereof, a door, and a compensating heating element so positioned as to compensate for heat lost through the door. (*Chem. Abs.*, **19**, 2396 (1925).)

Talwalkar, T. W., and Parmelee, C. W.

MEASUREMENT OF PLASTICITY. *Jour. Amer. Ceram. Soc.*, **10**, 670 (1927).—The object of this investigation was to devise a rational method and primary standard for measuring plasticity. Various methods suggested in the past were critically examined and found wanting. An apparatus was developed to measure the stress-strain relations of clays in shear and a few typical clays have been examined by his method. A definition is proposed for the unit of plasticity as follows:

$$\text{Index of plasticity} = \frac{\text{Total deformation at fracture in shear}}{\text{Average stress beyond proportional limit}}$$

The effect of addition of sand and powdered graphite has been noted and throws some light on the nature of plastic deformation. (*Ceram. Abs.*, **6**, 469 (1927); *Chem. Abs.*, **21**, 3436 (1927).)

Taylor, W. A.

HYDROGEN-ION CONTROL IN CERAMICS. *Jour. Amer. Ceram. Soc.*, **10**, 243 (1927).—Many technical as well as nontechnical men hesitate to use hydrogen-ion control because they feel that its application requires the services of a highly trained chemist. This paper shows, by a simple nontechnical discussion of the subject and by a demonstration of the method of making measurements, that a plant foreman can apply it just as easily

and accurately as a trained chemist. (*Ceram. Abs.*, **6**, 239 (1927); *Chem. Abs.*, **21**, 1874 (1927); *Chem. and Ind.*, **46B**, 442 (1927).)

***Teetor, P.**

THERMAL STUDY OF BORIC ACID-SILICA MIXTURE. See Bleininger, A. V. (this *Bibliography*, p. 28).

***Tennessee Enamel and Mfg. Co.**

ENAMELING CAST IRON. See *Ceram. Ind.* (this *Bibliography*, p. 55).

Thibaud

LAMPS AND BLAST APPARATUS FOR ENAMELING. *Br. d'inv.*, **69**, 451. (*Rep. der Tech. Lit.*, p. 272 (1823–1853).)

***Thiessen, G.**

CARBON BLACK, ITS PROPERTIES AND USES. See Perrott, G. St. J. (this *Bibliography*, p. 234).

Thlee und Horne

PHOSPHORESCENT ENAMEL. *Chem. Cbl.*, **14**, 94. (*Rep. der Tech. Lit.*, p. 119 (1882–1884).)

Thomas, Albert H.

PRODUCTION SCHEDULE. *Ceram. Ind.*, **9**, 53 (1927).—In order to build a workable production schedule the superintendent must know the capacities of his equipment and workmen should eliminate all unnecessary motion. (*Ceram. Abs.*, **6**, 412 (1927).)

Thomason, Wm.

PORCELAIN ENAMELING OF IRON CASTINGS. *Ind. Chemist*, **1**, 273 (1925).—A review. (*Ceram. Abs.*, **4**, 299 (1925); *Chem. Abs.*, **19**, 2869 (1925).)

***Thompson**

See Bingham, E. C. (this *Bibliography*, p. 24).

Thompson, E. M.

ENAMELED WARE. U. S. Pat. 355,486, Jan. 4, 1887.—As an article of manufacture, a vase or other article formed of enamel deposited upon a woven wire foundation.

Thompson, T. E.

BAKING ENAMELS. U. S. Pat. 1,558,517, Oct. 27, 1925.—Powdered fused enamel is applied to automobile bodies or other articles to be coated together with a fluid vehicle such as linseed oil or varnish which leaves a binding residue, and the coated articles are then baked at a temperature below the fusion point of the enamel. (*Ceram. Abs.*, **5**, 81 (1926); *Chem. Abs.*, **20**, 100 (1926).)

Thompson, W. P.

IMPROVEMENTS IN THE MANUFACTURE OF GLAZES, ENAMELS, ETC. British Pat. 9611, May 13, 1893.—Silica in glazes may be partly replaced by titanic acid without becoming colored, provided the fusion is conducted in an oxidizing atmosphere. The resulting glazes are said to be more fusible than those containing an equivalent of silica, to be more resistant to corrosive agencies, also to possess a high specific gravity, good luster, and a large coefficient of expansion. The latter quality permits their use direct upon ironware, which has hitherto generally been coated in two operations, the underglaze having a suitable coefficient of expansion and the upper being resistant

to acids. When a moderate amount of titanic acid is used, the glaze is transparent, and when a large quantity is employed an opaque glaze or enamel is produced. A typical mixture for the former is made from 15 to 30 parts of nitrate of soda, 116 of soda, 33 to 50 of carbonate of lime, 60 to 360 of quartz, 62 to 83 of boric acid, and 20 to 80 of titanic acid, while one for the latter is composed of 15 to 30 parts of nitrate of soda, 116 of soda, 100 of carbonate of lime, 60 to 180 of silicic acid, and 80 of titanic acid. Variations in the mixtures and the addition of coloring are also claimed. (*Chem. and Ind.*, **13**, 519 (1894).)

Thonind., **3**, 282; *Gew. Bl. Bayr.*, **11**, 304.

A LEAD-TIN FREE ENAMEL GLAZE. (*Rep. der Tech. Lit.*, p. 142 (1879–1881).)

Thorpe, F. Q.

AUTOMATIC TEMPERATURE CONTROL IN ENAMELING INDUSTRY. *Enamelist*, **1** [5], 9 (1924).—Article describes the operation of automatic control pyrometers.

Thurston, Samuel H.

ENAMELING METAL PROCESS AND RESULTING PRODUCT. U. S. Pat. 826,628, July 24, 1906.—The process consists in first forcibly beating one metal into and upon the other systematically and continuously until the particles or molecules of the coating metal are driven into the metal being coated and incorporated with the particles at and beneath the surface, and then forming a coating of enamel upon the coating of metal.

***Tinker, J. A.**

ENAMELING STEEL, ETC. See York, D. A. (this *Bibliography*, p. 343).

***Titanium Alloy Mfg. Co.**

RESULT OF CERTAIN RESEARCHES RELATIVE TO THE DEVELOPMENT AND USE OF ZIRCONIUM OXIDE PRODUCTS AS OPAQUING AGENTS IN VITREOUS ENAMELING PROCESSES. See Kinzie, C. J. (this *Bibliography*, p. 173).

Tomekichi, Bessho, and Iwataro, Ito

MAKING ENAMELED SHEET-IRON WARE WITHOUT GROUND COAT. Japanese Pat. 9,629, July 28, 1926.—The single-coat enamel is composed of red sand (powdered silica sand) 33.0, borax 19.5, cryolite 6.0, fluorspar 7.0, Chili saltpeter 6.0, sodium carbonate 9.0, feldspar 10.0, and antimony oxide 3.5. (*Ceram. Abs.*, **6**, 505 (1927).)

Tomes, C. S.

ENAMELS. *Jour. Soc. Arts*, **48**, 734 (1900).—T. has carried out experiments to ascertain the reason of the well-known fact that the brilliancy and transparency of fused enamels depend to a considerable extent upon the coarseness of the enamel powder. If a satisfactory transparent enamel be desired, it is essential that the enamel, after reduction to a fine powder, be washed, prior to its application to the work; the lighter portions, which eventually settle from the washing water as a fine mud, being rejected. A sample of an ordinary transparent flux, of fairly high fusing point, which, after powdering in an agate mortar, was applied to a piece of gold without being previously washed, fused into a cloudy film, which, on microscopic examination, was found to owe its opacity to an infinite number of minute, round air bubbles; no solid opaque particles could be detected, nor was the matrix between the bubbles at all opalescent. A sample of the same enamel, when washed before being applied, yielded a perfectly transparent, colorless film, containing but few air bubbles, and these of large size. Cunynghame has suggested that the opacity of films produced with unwashed enamels is due to the

partial decomposition of the enamel by the action of carbonic acid upon the alkali which it contains, the carbonate of soda or potash formed, on heating, being again decomposed by the silica, with the liberation of minute bubbles of carbonic acid gas. T. rejects this explanation and states that what probably happens, when unwashed enamels are used, is that the very fine particles, especially on the surface, become very quickly agglutinated by the heat of the furnace, entangling between and beneath them an infinity of fine bubbles; when coarser particles are fired, they run together more slowly, the air escaping for the most part, while the little which remains forms large bubbles, which do not appreciably interfere with the transparency of the film. It was observed that if an enamel reduced to impalpable powder be applied in a sufficiently thin layer, most of the air is able to escape before the surface glazes, and so a fairly transparent film is obtained. (*Chem. and Ind.*, **19,** 902 (1900).)

Tonind.-Ztg., **40,** 244 (1916).

NEW OPACIFIER FOR THE CERAMIC INDUSTRIES.—White glazes containing ZrO_2 as opacifier have recently been put on the market under the name of "Terrar" glazes. The glazes show satisfactory gloss and opacity and when mixed with 10 to 20% SnO_2 cannot be distinguished from pure tin glazes. (*Chem. Abs.*, **11,** 1282 (1917).)

Topping, Wilbur

COMPOSITION FOR ENAMELING METALWARE. U. S. Pat. 663,618, Dec. 11, 1900.—The formula used was: 61 parts borax, 71 parts feldspar, 44 parts quartz, 15 parts fluorspar, 14 parts soda, 11 parts saltpeter and water.

Tostmann, C.

FUNCTION OF GROUND ENAMEL. *Keram. Rundschau,* **19,** 5 (1911).—The claim is reasserted that in ground enamels on cast iron the cobalt oxide is reduced to cobalt. (*Chem. Abs.*, **5,** 1670 (1911).)

Tostmann, C.

SALTPETER REPLACEMENT IN ENAMEL INDUSTRY. *Keram. Rundschau,* **23,** 15 (1915).—Oxidizing agents which might replace KNO_3 are too expensive or depend upon it in manufacture. Reduction may be prevented by good draft in the furnace. Use of tin oxide or zirconium oxide instead of antimony oxide lessens the need of KNO_3. Tostmann reports success in the use of sodium chloride to remove iron. (*Chem. Abs.*, **9,** 3341 (1915).)

Tostmann, Carl

SIGNIFICANCE OF COEFFICIENT OF EXPANSION IN CERAMICS. *Sprechsaal,* **43,** 623, 638 (1910).—A critical review of the literature dealing with the subject of crazing. The results of Seger have not yet been disproved. The different results of Binns, Purdy, and others are to be attributed to the vaporization of metaboric acid at low temperatures, the solution of the body, and other causes. Crazing may be due not only to differences in the coefficient of expansion but also to the unequal cooling of a heavy piece of ware in which the elasticity of a glaze comes into consideration. The coefficient of expansion may also be changed due to chemical combination. Staley is criticized for ascribing crazing to the contraction on solidification, which is equivalent in reality to the coefficient of expansion. (*Chem. Abs.*, **5,** 361 (1911`.)

Totot-Gibaru, C.

ENAMELING OF CAST AND SHEET METAL. British Pat. 262,159, June 16, 1925.—A process for enameling metal by the "dry" method consists in applying a mixture of

silica 2 to 25%, zinc oxide 20 to 35%, hydrated borax 35 to 70%, alkali nitrate 2 to 20%, alkali fluorides 0 to 8%, and calcium carbonate 0 to 30%. If additional opacity is required, antimony oxide or stannic oxide is added. A decorative effect may be obtained by superposing on the above enamel, by the dry method, a mixture containing 5 to 15% SiO_2, 1 to 3% Al_2O_3, 10 to 20% CaO, 30 to 40% ZnO, 12 to 18% alkalis, 15 to 30% B_2O_3, 1 to 3% F, with oxide of iron, cobalt, or manganese to color. (*Ceram. Abs.*, **6**, 169 (1927); *Chem. Abs.*, **21**, 3724 (1927); *Chem. and Ind.*, **46B**, 109 (1927).)

Totot-Gibaru, C.

LEAD-FREE ENAMELS. French Pat. 597,146, Aug. 6, 1924.—An enamel flux free from lead consists of 2 to 20 parts of silica, 5 to 35 zinc oxide, 30 to 70 crystallized borax, 2 to 20 alkali nitrate, 0 to 8 alkali fluoride, and 0 to 30 calcium carbonate. Tin oxide or antimony trioxide is used as opacifier. (*Chem. and Ind.*, **45B**, 323 (1926).)

Totot-Gibaru, C.

LEADLESS ENAMELS. French addition 30,444 to French Patent 597,146, May 1, 1925.—The metal is first coated with a powdered mixture containing, *e.g.*, 22.63% SiO_2, 3.76% Al_2O_3, 3.5% CaO, 23.44% ZnO, 16.6% Na_2O, 2.63% K_2O, 12.5% Sb_2O_3, 13.72% B_2O_3, and 2.02% F, then with a similar mixture containing, *e.g.*, 15.06% SiO_2, 1.08% Al_2O_3, 12.65% CaO, 18.48% Na_2O, 30.12% ZnO, 21.15% B_2O_3, and 2.43% F. (*Ceram. Abs.*, **6**, 10 (1927); *Chem. and Ind.*, **45B**, 879 (1926).)

Totot-Gibaru, C.

ENAMELING SHEET IRON. French Pat. 610,645, Feb. 5, 1926.—The cleaned sheets are heated at 420° and covered with an enamel containing fluorine, boric acid, zinc oxide, and antimonious oxide in a lead-free flux containing silica, alumina, lime, and alkali. Subsequently, a second layer of enamel similar to the first is applied, but containing stannic oxide and pigments such as ferric, manganous, or cobalt oxide in place of the antimony oxide of the first layer. For sanitary ware a second layer similar to the first may be used instead of the colored layer. (*Chem. and Ind.*, **46B**, 779 (1927).)

Trainer, E.

ENAMEL. U. S. Pat. 589,554, Sept. 7, 1897.—Glazes, glass, or enamels having with silica, an alkali compound and an admixture of a minimum quantity of 5% of a phosphate of an alkali metal, such phosphate acting as a flux and a dulling agent.

Traube, I.

ENAMEL FOR METALS OR EARTHENWARE. British Pat. 221,830, Sept. 14, 1923.—Any suitable glazing material is formed into a thick mixture with an aqueous solution of compounds which will form precipitates remaining insoluble at fusing temperature, *e.g.*, a solution of K chromate and a solution of $MnSO_4$ may be mixed with separate portions of the glazing material and the masses thus formed applied superposed or side by side. Fe oxide, chrome green, or the like may be used to produce mottled effects. (*Ceram. Abs.*, **4**, 127 (1925); *Chem. Abs.*, **19**, 879 (1925); *Chem. and Ind.*, **45B**, 90 (1926).)

Treischel, Chester

CAUSE AND CONTROL OF "BLISTERING" IN SHEET-STEEL ENAMELING. *Jour. Amer. Ceram. Soc.*, **2**, 774 (1919).—Hydrogen has much to do with blistering. Ware pickled in a strong solution of acid all showed blistering. Pickling in weak solution of acid will not cause this. Hydrogen ions, lodging in the minute cavities caused by the rolled-out blowholes in the sheet steel, expand upon heating causing the separation of the sheet accompanied by a noticeable blister at this point. *Remedy:* Pickle in 3%

acid solution and rub each piece with a brush before washing to help remove some of the adhering scale. (*Chem. Abs.*, **14,** 107 (1920); *Chem. and Ind.*, **39A,** 25 (1920).)

Treuhand Ges. für Elektrische Glühlampen

RED GLAZES AND ENAMELS. German Pat. 421,424, May 27, 1924.—Red glazes and enamels are prepared by adding chromates, particularly dichromates, and one or more opacifying agents to a basic glass. A layer of the glaze 0.05 mm. thick is colored, by this means, red throughout. (*Chem. and Ind.*, **45B,** 275 (1926).)

Tucker, Gus M.

EFFECT OF NICKEL SALTS ON THE COLOR. *Ceramist*, **1,** 268 (1921).—A study of the colors produced by various compounds of nickel.

Turk, Karl

THE READY REMEDIER.—A manual published for porcelain enameling superintendents. Published by Porcelain Enamel and Mfg. Co., Baltimore, Md., 1927.

Turk, Karl

LOW ENAMEL PRODUCTS COSTS. *Ceram. Ind.*, **4,** 453 (1925).—A description of the advances in the art of enameling that have reduced costs. (*Ceram. Abs.*, **4,** 331 (1925).)

***Turk, R. H.**

OBSERVATIONS ON AGING OF ENAMELS. See Wolfram, H. G. (this *Bibliography*, p. 341).

***Turner, W. E. S.**

DETERMINATION OF BORIC OXIDE IN GLASS. See Cauwood, J. D. (this *Bibliography*, p. 49).

Tuthill, J. M.

BEST EQUIPMENT FOR ENAMELING SHEET-STEEL AND CAST-IRON STOVE PARTS. *Enamelist*, **1** [6], 5 (1924).—Good equipment for the ordinary plant. (1) *Sandblasting:* Sandblast barrel in addition to a humane table. (2) *Pickling:* Cleaner tank, rinse tank, sulphuric acid tank, rinse tank, and neutralizing tank. An acid-proof basket carries the ware from one tank to another by means of an electric hoist. From the neutralizing tank it is placed on rollers and rolled into driers. Temperature and strength of solution should be controlled. (3) *Dipping:* Galvanized-lined tables, with slanting drain boards. (4) *Spraying:* For cast iron there should be a single exhaust fan for every booth. For sheet steel most plants can easily use a continuous spraying machine. (5) *Drying:* Waste heat can be carried to drying room. Continuous driers are more effective and save space. (6) *Firing:* Best muffles are Carborundum. Carborundum piers should be used for supports. Good fork equipment is necessary so that heavy loads can be lifted easily and carried back and forth into the furnace with very little trouble. (7) *Milling:* There should be a mill for each color. Each mill should have its own motor.

Twells, Robert

HANDLING AND STORING RAW MATERIALS TO PRODUCE UNIFORMITY OF A BODY. *Jour. Amer. Ceram. Soc.*, **7,** 82 (1924).—Ceramic raw materials are usually heterogeneous rather than pure substances. Variations in composition are likely to occur in materials as received, both within carloads and between successive carloads of the same material. The article describes ways of avoiding trouble from such variations. (*Chem. Abs.*, **18,** 1040 (1924).)

***Twells, Robert**

HOW MUCH DOES DIRT COLLECT FROM DIVIDENDS? See Mitchell, H. J. (this *Bibliography*, p. 218).

***Tyler, W. S.**

PLASTICITY. See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 43).

Tytus, John B.

SHEET-PICKLING METHOD. U. S. Pat. 1,572,583, Feb. 9, 1926.—A process for electrolytically treating iron or steel pieces which because of their width must be produced in short length, which consists in uniting the pieces end to end, feeding the band so formed through an electrolyte containing suitable electrodes and establishing current connection with the band to convert it into an electrode. (*Ceram. Abs.*, **5**, 117 (1926).)

Uchida, T.

OPACITY AGENTS FOR ENAMELS. *Jour. Jap. Ceram. Assn.*, **357**, 189 (1922).—Although antimony, which is generally used in Japan for making white enamels, is inexpensive and effective, as far as opacity is concerned, it is by far inferior to stannic oxide as to the appearance of enamel and, moreover, enamels with antimony cannot be exported to some countries where their use is forbidden; consequently the study of its substitutes is needed. The results of numerous experiments in which various substances were ground with ten times its weight of frit, made from 26 kg. borax, 59 kg. feldspar, 2 kg. niter, and 13 kg. cryolite, applied on sheet iron and fired after drying are as follows: (1) Among opacifiers on market and those substances which were considered of high promise, only two specimens of stannic oxide proved to be excellent. Terrar, zirconia, cerium carbonate, and a specimen of stannic oxide were good and antimony oxide, rutile, and Izushi clay were fair; (2) of various metal oxides, obtained by calcining oxalates, those of tin, zirconium, antimony, and cerium were good and the oxides of lead, zinc, and arsenic were fairly good; (3) among several compounds of tin, stannic oxide obtained by calcining the hydroxide at 1050°C was excellent and stannic hydroxide was good; (4) antimonic anhydride and antimony tetroxide are better than the trioxide; (5) of various antimonates and stannates, only calcium antimonate proved an excellent opacifier, and zinc stannate was fair; (6) the process of manufacturing a compound affects its quality as an opacifier, *e. g.*, the stannic oxides which have been manufactured by igniting metastannic acid, $SnO(OH)_2$, obtained by oxidizing metallic tin with nitric acid, at 670 to 1060°C have proved fairly good opacifiers while good ones have been obtained by heating it at 1100 to 1230° and at last excellent ones at 1280 to 1435°; (7) the oxides, silicates, and phosphates of aluminum and magnesium deteriorate the luster of enamels. (*Ceram. Abs.*, **1**, 294 (1922); *Chem. Abs.*, **16**, 3535 (1922).)

Uchida, Tokiji, and Arimoto, Kazuo

STUDY OF ACID-RESISTING ENAMELS. *Osaka Ind. Lab. Bull.*, **4**, No. 1 (1923).—The influences of variation in the composition of enamel-frits upon their resistance to sulphuric acid have been determined, starting from standard frits which contain basic flux (Na_2O, $^1/_3Na_3AlF_6$, or PbO), refractory base ($^1/_2Al_2O_3$, CaO, ZnO, BaO, or MgO), acid flux (B_2O_3) and refractory acid (SiO_2, TiO_2, or ZrO_2)$_4$ in the ratio of 1.0:0.6::0.5:2.4. The solubility was compared by putting 2 grams of frit with fineness of 900- to 1000-mesh per sq. cm. in a weighing bottle containing 10 cc. of 10% sulphuric acid and by leaving them for 48 hours at 20°C under normal pressure. (1) Effect of basic fluxes on resistance to acid. (*a*) Their effect is practically similar, but soda is better than cryolite or lead oxide. (*b*) Excess of cryolite causes difficulties in melting as it badly corrodes

the pot, while two small proportions make the frit too refractory. The best result is obtained with 0.8 equivalents. (2) Effect of refractory base on resistance to acid. (*a*) The effect is very marked. The best result is obtained with barium oxide followed by magnesium oxide. Oxides of zinc, aluminum, and calcium are detrimental. (*b*) The series 0 to $1.0BaO \cdot {}^1/_2Na_2AlF_6 \cdot 0.5B_2O_3 \cdot 2.4SiO_2$ is least soluble at 0.3 BaO. (3) Effect of acid flux on resistance to acid. (*a*) Resistance is reduced by an increase in boric acid; 0.3 B_2O_3 is most suitable, since a smaller content makes the frits too refractory. (4) Effect of refractory acid on resistance to acid. (*a*) The effect is remarkable. Only silica is satisfactory among the three acids. (*b*) Resistance increases as the content of silica rises. (5) Effect of mutual replacement of base and acid on the resistance to acid. (*a*) Experiments on series 1.0 to 0 BaO or MgO; 2.0 to $3.0SiO_2 \cdot {}^1/_2Na_2AlF \cdot 0.5B_2O_3$ show that good frits are obtainable only in some definite ratios of the base and the acid, 0.6 BaO or MgO: $2.4SiO_2$ being best for the series. (*b*) Solubility of series 0.6 to $1.5 \cdot {}^1/_2Na_2AlF_6 \cdot 0.9$ to $0B_2O_3 \cdot 0.6BaO \cdot 2.4SiO_2$ decreased with the content of cryolite. Considering the difficulties caused by its corrosive action on pot, the proportion $1.0 {}^1/_2Na_2AlF_6 : 0.5B_2O_3$ seems to be most suitable. (6) Production of the best frit. Since the experiments hitherto described have indicated that Na_2O, B_2O_3, BaO, and SiO_2 are most desirable constituents of acid-proof enamels, the authors then started to find their best proportion, keeping the ratio of fluxes and refractory oxides at 1.3:3.7 in equivalents and also the contents of soda and boric acid as 1.1 and 0.2, respectively. The best frit thus obtained is 0.3 BaO, 3.4 SiO_2, 1.1 Na_2O, 0.2 B_2O_3. The frit loses only 0.28% in the test, and is quite satisfactory in other respects, such as melting point, firing luster, firing color, and adherence to iron. (*Ceram. Abs.*, **2**, 240 (1923); *Chem. Abs.*, **17**, 3590 (1923).)

Underhill, D.

ENAMELED CAST-IRON SANITARY WARE. *Foundry*, **36**, 17 (1908).—A good general survey of the entire field gives characteristic formulas for slush coats and enameling mixtures, showing the office of each ingredient and effect on the final product. (*Chem. Abs.*, **4**, 2868 (1910).)

Underwood, C. A.

ANALYSIS OF HIGH ALUMINA PRODUCTS. *Bull. Amer. Ceram. Soc.*, **2**, 152 (1923).—Determination of "loss on ignition," silica, alumina, iron oxide, titania, calcium oxide, magnesia, potash, and soda.

Underwood, J. A.

EFFECT OF PORCELAIN ENAMEL IN THE STOVE INDUSTRY. *Enamelist*, **4** [8], 11 (1927).—Paper read before the National Stove Manufacturers Association.

***U. S. Bur. of Agriculture**

ACID TEST ON ENAMELWARE. See Collins, W. D. (this *Bibliography*, p. 72).

U. S. Bur. Stand., *Circ.*, No. 80.

METALLIC COATING FOR RUST PROOFING OF IRON AND STEEL.—Attempts to protect iron and steel against corrosion have led to the use of various materials for coatings, such as metallic coatings, oxide coatings, organic coatings, such as paints and varnishes, and vitreous enamels. This paper deals particularly with metallic coatings but contains much material of interest to those coating metals with other substances, such as vitreous enamels. The section on pickling and cleaning metals and the effects of these processes on the mechanical properties of steel will be of special interest to manufacturers of enameled ware. A well-selected and classified bibliography dealing

with the general subject of corrosion is appended. (*Jour. Amer. Ceram. Soc.* (Abs.), **2**, 844 (1919).)

U. S. Bur. Stand., *Tech. News Bull.*, No. 40 (1920).

RELATION OF COMPOSITION TO SOFTENING POINT OF ENAMELS.—The Bureau has undertaken a study of the relation of composition to the softening point of enamels. From the data obtained so far it may be stated that the effect of various constituents on the softening point is not in accord with the chemical similarity of these constituents. For instance, certain basic oxides act as refractories in enamels, while others act as fluxes. The same is true for the so-called intermediate oxides and the acid oxides. In a given chemical group of oxides, the fluxing effect is not in proportion to the molecular weight, and on the other hand equal percentage amounts of the various oxides do not have the same fluxing effect. The action of each oxide and mineral used in compounding enamels seems to be characteristic of that particular mineral or oxide and cannot be calculated by any system of *a priori* reasoning. (*Jour. Amer. Ceram. Soc.* (Abs.), **3**, 855 (1920).)

U. S. Bur. Stand., *Tech. News Bull.*, No. 41 (1920).

RELATION OF COMPOSITION OF ENAMEL TO SOLUBILITY IN ACIDS.—During the progress of this investigation, it was noticed that in a large number of cases enamels scratched to some extent after being subjected to the action of boiling acid for only a few hours but after continued treatment would not scratch at all. This led to the conclusion that possibly the boiling acid had some annealing effect upon the enameled surface that made it more resistant. It has been found that boiling enamels in oil for several hours before subjecting them to the acid treatment entirely eliminated this preliminary scratching and softening of the surface. Boiling in water had a similar but not as great an effect as boiling in oil, while simply heating the pieces in air had little effect. It would seem advisable to treat with boiling oil all enameled ware which is to be subjected to the action of corrosive liquids. (*Jour. Amer. Ceram. Soc.* (Abs.), **3**, 856 (1920).)

U. S. Bur. Stand., *Tech. News Bull.*, No. 41 (1920).

FISHSCALING OF SHEET-STEEL ENAMELS.—As one phase of a comprehensive investigation of this subject, the relation of cold-working of the steel, such as is undergone by steel shapes which are pressed into form before enameling has been studied. It has been found in a number of cases that stretching the steel eliminated fishscaling, which had occurred on unstretched steel of the same lot. These results confirm the observations made in practice that those parts of vessels which have been spun or stretched in shaping are often free from fishscaling in enamel, while the parts that have not been stretched contain fishscales. (*Jour. Amer. Ceram. Soc.* (Abs.), **3**, 856 (1920).)

U. S. Bur. Stand., *Tech. News Bull.*, No. 43 (1920).

FISHSCALING OF GROUND-COAT ENAMELS.—The study of the cause and control of fishscaling of ground-coat enamels has been continued, by the preparation of two series with a total of 14 enamels, in one series the feldspar being high, while in the other the quartz is high. In each series, the fluxes are varied in a systematic manner. The results obtained thus far agree with those for grayware enamels, that is, the constituents which tend to promote or retard fishscaling have the same results in the two types of enamels. Furthermore, it was found that there was little tendency to fishscale in three-coat enamels applied to low copper steels which agrees with the results obtained with one-coat enamels. The determinations of the thermal expansion of various types

of enamel used for coating sheet steel are being continued. (*Jour. Amer. Ceram. Soc.* (Abs.), **3**, 1011 (1920).)

U. S. Bur. Stand., *Circ.*, No. 152.

RECOMMENDED SPECIFICATIONS FOR CERAMIC WHITING.—This is the fifth of a series of specifications for the kinds of lime required by different chemical industries. The preceding four dealt, respectively, with lime used in cooking rags, in causticizing, in the manufacture of sulphite pulp, and in the manufacture of glass. This deals with lime used in making glazes, enamels, and similar ceramic products. Ceramic whiting is really calcium carbonate, with or without a small amount of magnesium carbonate, but it performs the function of lime. It should contain not less than 97% of carbonates, and should be very fine, so that 98% of it will pass a No. 200 screen. (*Ceram. Abs.*, **3**, 122 (1924).)

U. S. Bur. Stand., *Tech. News Bull.*, No. 101, Sept. 1925.

FLOTATION OF ENAMELS.—A study of the factors governing the behavior of enamels suspended in water as used for coating metal shapes. (*Ceram. Abs.*, **4**, 331 (1925).)

U. S. Bur. Stand., *Tech. News Bull.*, No. 111, p. 1 (1926).

EFFECT OF TYPICAL ENAMELS ON COLORS OBTAINED WITH VARIOUS STAINS.—Results of investigation using three typical enamel formulas of varying composition and of the commercial type show: (1) Very thorough mixing of coloring material added before smelting is necessary to produce uniform results. (2) Variations in tint of coloring oxides may affect the shade of the resultant enamel and may be corrected by variation of the amount of oxide added. (3) Calcined alumina in proper amounts may be used, as a diluent in preparation of oxides. (4) Procedures and conditions must remain constant to duplicate any oxide. (5) A minimum clay addition to the mill batch, compensated for by finer grinding, is necessary to eliminate "scumming" of the fired surface. (*Ceram. Abs.*, **5**, 298 (1926).)

U. S. Bur. Stand., *Tech. News Bull.*, No. 116, p. 4 (1926).

FLOTATION OF ENAMELS.—This investigation includes the study of factors affecting the consistency of enamel slips in order to control their working properties. Four conclusions are given relative to mobility and yield value. (*Ceram. Abs.*, **6**, 95 (1927).)

U. S. Bur. Stand., *Tech. News Bull.*, No. 121, pp. 10–11 (1927).

FURTHER INVESTIGATION OF FELDSPAR.—Work has been done on the effect of feldspars on (1) relative glaze fit, (2) mechanical strength, volume shrinkage, and porosity of vitreous and semivitreous bodies, and (3) thermal expansion of vitreous and semivitreous bodies. Methods of conducting tests are described, and some results are given. (*Ceram. Abs.*, **6**, 350 (1927).)

U. S. Bur. Stand., *Tech. News Bull.*, No. 122, p. 10 (1927).

LIGHT-COLORED FIRST-COAT ENAMELS FOR SHEET IRON.—There is now in progress at the Bureau an investigation to eliminate the necessity for the dark first coat of enamel (base coat) either through the development of a light-colored enamel which by virtue of its composition has an adhesiveness comparable to that of the cobalt base or through improving the technique of application. Several different opacifying materials added in the raw state have been studied and included tin oxide, zirconium silicate, zirconium oxide, and sodium antimonate, of which the latter two gave promise of satisfactory behavior for this use. A test of enamel adherence has been included as an integral part of this problem. (*Ceram. Abs.*, **6**, 373 (1927).)

U. S. Bur. Stand., *Tech. News Bull.*, No. 123 (1927).

FURTHER INVESTIGATION OF FELDSPAR.—Thermal expansion observations on two series of semivitreous bodies fired to cone 8, using two different formulas, one developed by the Bureau and the other suggested by the Whiteware Advisory Committee. The data indicate: (1) a noticeable increase in rate of expansion in the range 560 to 600°C for specimens of all firings; (2) all bodies containing the high potash feldspar show the smallest percentage of expansion at 700°C for all of the different rates of firing and cooling used. The expansion appears to increase in Na_2O content of the feldspar, the relation being affected by the uncombined silica content also. The expansion for the high potash bodies is lowest when fired to cones 8 and 10 and highest when fired to cone 4 with a difference of about 0.04%. (*Ceram. Abs.*, **6**, 452 (1927).)

U. S. Bur. Stand., *Tech. News Bull.*, No. 124, p. 8 (1927).

CONFERENCE ON CAST-IRON FOR ENAMELING PURPOSES.—Program of future work on this problem agreed upon between representatives of the AMERICAN CERAMIC SOCIETY and the Bureau. This program deals with the method of applying enamel to each iron under a variety of conditions instead of a single standard condition and distinguishing between irons according to the magnitude of the range of conditions under which each will produce blister-free ware. (*Ceram. Abs.*, **6**, 505 (1927).)

***U. S. Bur. Stand. (Advisory Committee on Ceramics)**

GLASS, ENAMEL, AND POTTERY RESEARCH DATA. See *Ceram. Ind.* (this *Bibliography*, p. 60).

***U. S. Bur. Stand.**

STUDY OF ATTERBERG PLASTICITY METHOD. See Kinnison, Charles S. (this *Bibliography*, p. 173).

RELATION BETWEEN ENAMEL AND STEEL STUDIED BY U. S. BUREAU OF STANDARDS. See *Ceram. Ind.* (this *Bibliography*, p. 58).

BUREAU OF STANDARDS INVESTIGATION OF POTTERY, HEAVY CLAY PRODUCTS, GLASS, AND ENAMELS. See *Ceramist* (this *Bibliography*, p. 63).

ENAMEL INVESTIGATIONS AT THE BUREAU OF STANDARDS. See *Chem. Met. Eng.* (this *Bibliography*,p. 64).

ENAMEL DIVISION COÖPERATIVE RESEARCH. See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 43).

INVESTIGATION OF FELDSPAR. See *Ceram. Ind.* (this *Bibliography*, p. 59).

BUREAU OF STANDARDS PUBLISHES RÉSUMÉ OF CERAMIC INVESTIGATIONS. See *Ceram. Ind.* (this *Bibliography*, p. 61).

BUREAU OF STANDARDS FINISHES STUDY ON FIRST-COAT ENAMELS. See *Ceram. Ind.* (this *Bibliography*, p. 59).

BUREAU OF STANDARDS STUDIES COMMERCIAL FELDSPARS AND CONTROL OF CLAY SUSPENSION. See *Ceram. Ind.* (this *Bibliography*, p. 58).

PRINCIPALS UNDERLYING PROPERTIES OF ENAMEL SUSPENSIONS. See *Ceram. Ind.* (this *Bibliography*, p. 58).

Unwin, D. J.

HEATING-INSULATING COVER FOR DOORS OF ENAMEL KILNS, OVENS, ETC. British Pat. 206,613, Aug. 23, 1922. (*Chem. and Ind.*, **43B**, 17 (1924).)

Urbschat, E. E.

INVESTIGATIONS ON ENAMELS. *Keram. Rundschau*, **34**, 259 (1926).—A freshly prepared H_2SO_4 bath acts better than one containing ferric sulphate; no advantage is gained by mixing an old acid solution with a new one; increasing ferric chloride concentration in a hydrochloric acid bath hastens the reaction; iron heated to redness before treating in an acid bath loses 300 to 400% more than unheated iron; the addition of hydrochloric acid or sodium chloride to a sulphuric acid bath retards the action of the bath. (*Ceram. Abs.*, **5**, 268 (1926); *Chem. Abs.*, **20**, 2736 (1926).)

Valere, J.

MANUFACTURE OF TRANSLUCENT ENAMEL. U. S. Pat. 441,514, Nov. 25, 1890.—The composition for translucent enamel consisting, essentially, of minium, boracic acid, oxide of zinc, stannic acid, clean sand, soda, feldspar, fluorspar, carbonate of potash, carbonate of lime, borax, nitrate of soda, and a suitable flux.

Vanes

ENAMELING. *Engl. Mech.*, **37**, 359; *Sc. Am. Suppl.*, p. 6175. (*Rep. der Tech. Lit.*, p. 119 (1882–1884)).

Verneuil, A.

PREPARATION OF BLACK ENAMEL OR LUSTER OF ITALIAN-GREEK POTTERY. *Chem.-Ztg.*, **35**, 259 (1911).—By using fine iron filings and sodium carbonate on clay containing lime and heating in the oxidizing flame a glazed, black, nontransparent enamel having a green reflection is obtained. (*Chem. Abs.*, **6**, 1216 (1912).)

Vielhaber, L.

FLUORSPAR IN ENAMELS. *Emaillew. Ind.*, **83** (1926).—Fluorspar is a cheap opacifying medium, which has no serious effect upon the expansion, elasticity, and strength of enamels. It has been used in many cases to increase the elasticity in order to prevent chipping of the enamel from corners, etc. Its effect upon the elasticity being great and upon expansion comparatively slight, it is suitable raw material for enamels for cooking utensils. (*Ceram. Abs.*, **5**, 384 (1926).)

Vielhaber, L.

REFRACTORIES FOR ENAMELERS. *Feuerfest*, **1**, 90 (1925).—Chemical action in batch furnaces discussed and importance of physical properties of refractories stressed. Smooth surface, fine grain, and low porosity are important. As the joints are more vulnerable than the brick, make them as thin as possible and use blocks as large as practical. Tanks in which melts containing a minimum of fluorides and borax are made show the longest life. (*Ceram. Abs.*, **5**, 91 (1926).)

Vielhaber, L.

FUEL CONSUMPTION OF MUFFLE KILNS IN ENAMELING INDUSTRY. *Keram. Rundschau*, **27**, 293 (1919).—The question whether producer-gas fired kilns are better than semigas-fired kilns in the enameling industry is important to those installing new kilns. It is admitted that the producer-gas ovens are successful in many metallurgical industries and will be important for the larger enamelware companies, but it is doubtful whether they are much better than the semigas-fired kilns now used extensively in Germany for small plants. A heat balance was run on an enamel muffle-oven which in 24 hours burns 1800 kg. of ware and 500 kg. of coal. The calculations were as follows: specific heat of enamel and iron = 0.15; melting point of enamel = 950°C; heat used in heating enamel and iron = $0.15 \times 1800 \times 950 = 256{,}500$ heat units; heat of fusion

of enamel = 70 heat units; 540 kg. of the 1800 kg. of ware is enamel, hence heat used in melting enamel = 70 × 540 = 37,800 heat units; heat used, 294,300 heat units; heat lost through opening of doors = 24 × 15 × 2640 = 950,000 heat units; since doors are opened 15 times per hour, through which the temperature drops 30°C. The muffle has a volume of 0.224 cu. m. of fire brick which weigh about 400 kg.; the specific heat of the brick is 0.22 and hence to heat 400 kg. to 30°C, 0.22 × 30 × 400 = 2640 heat units are used; the producer gas is heated to 450°C. One kg. of coal produces 12.8 cu. m. of gas, which has a value of 6592 heat units. In 24 hours 500 × 6592 = 3,296,000 heat units are given up by the gas; theoretical air necessary = 6.04 kg.; practical air necessary = 8.45 kg.; excess air = 2.41 kg.; theoretical products of combustion = 11.45 kg.; products of combustion from 1 kg. coal = 13.86 kg. or 6930 kg. for 500 kg. Since gases leave recuperator at 500°C, the following heat is lost in the smoke stack: 0.255 × 500 × 6930 = 883,575 heat units

	Heat units
Heating enamel	256,500
Melting enamel	37,800
Radiation loss	1,186,560
Lost through opening doors	950,000
Lost through chimney	883,575
	3,314,435

If the gas passes to recuperator at 800°C there are: 0.255 × 800 × 6930 = 1,413,720 heat units; heat passing through chimney = 883,775 heat units. Saved by recuperator, 529,945 heat units. If air in recuperator is heated to 490°C, 520,240 heat units are saved by the recuperator, or 76 kg. of coal are saved per 24 hours. Heat used is as follows: enamel heating = 256,500 heat units; heat of fusion = 37,800 heat units, giving a total of 294,300 heat units. Converting coal in generators to gas also requires heat, the coal having a heating value of 7530 and the gas from 1 kg. of coal 6592 heat units, so 939 heat units are used in converting 1 kg. of coal to gas, or 469,800 heat units for 500 kg. From these results V. believes that the semigas-fired kilns with a small recuperator would give results very similar to the above. (*Jour. Amer. Ceram. Soc.* (Abs.), **3,** 83 (1920); *Chem. Abs.*, **14,** 811 (1920); *Chem. and Ind.*, **38A,** 862 (1919).)

Vielhaber, L.

BEHAVIOR OF METAL OXIDES IN GROUND COATS ON SHEET METAL. *Keram. Rundschau,* **33,** 53 (1925).—Sections of iron and enamel were made and the adhering film investigated with a microscope. The adhering film is no metal, but consists of a mixture of oxide and enamel. In enamels containing no metal oxides, there is a green color near the iron due to dissolved iron oxide. The film of iron oxide is missing in enamels free from metal oxides because the iron dissolves. The adhering of the ground coat on cast iron is exactly the same as for sheet steel. The ground coat on cast iron does not smelt completely and therefore the dissolving of iron into the enamel is not possible. The complete dissolving of the iron oxide on sheet steel enamels is prevented by the use of cobalt or nickel oxide. (*Ceram. Abs.*, **4,** 156 (1925); *Chem. Abs.*, **19,** 2869 (1925).)

Vielhaber, L.

OXIDE OF ANTIMONY IN ENAMELS. *Keram. Rundschau,* **35,** 516 (1927).—A discussion of the proper amount of antimony oxide to use in enamels, and of the amounts and effects of same which go into solution particularly when cooking foods containing acetic acids or fruit acids. Mention is made of the steps taken in Holland toward controlling the amounts used. It is pointed out that the amounts set free are so small

that poisoning therefrom is almost absolutely unknown. V. concludes that an attempt to control the amounts of this oxide so used, as a health consideration, is quite unnecessary and imposes unnecessary hardships on the manufacturers. (*Ceram. Abs.*, **6**, 568 (1927).)

***Vitreous Steel Products Co.**

TABLE TOPS SOLE OUTPUT OF PLANT. See *Ceram. Ind.* (this *Bibliography*, p. 51).

***Vitrified Iron Products Co.**

INTERCHANGEABLE AIR SYSTEM REDUCES COSTS IN ENAMELING PLANT. See *Ceram. Ind.* (this *Bibliography*, p. 53).

Vodicka, A. L.

DRY-PROCESS ENAMELING. *Enamelist*, **4** [2], 10 (1926).—The present-day enamel is much softer than those years ago. Dry-process enameling has been in use about 40 years; before this cast iron was enameled by the wet process, using a hard white first coat and two white cover coats. Undersmelting will cause pinholes, pits, and sometimes pink spots; an enamel melted too hard will be off color, and becomes brittle causing chipping. The frit must be dry before it is milled. Fresh castings require only a good sandblasting for cleaning; old castings, rusty, or oily require annealing or pickling, and sandblasting. The casting should be enameled shortly after cleaning. The first coating of enamel should be a thin even coat and fired at 1650 to 1800°F.

Vogel, H.

ENAMELING OF CAST-IRON WARE. *Keram. Rundschau*, **23**, 109 (1915); *Z. angew. Chem.*, **28**, 411 (1915).—Hard, white cast iron gives a better surface for enameling than soft gray iron, but it is brittle and warps easily. Surfaces to be enameled are chilled in casting or hardened by sulphur. Graphite in the iron affords a poor surface for enamel. Castings are cooled quickly to avoid separation of carbon as graphite. Castings should be of uniform thickness, about 2.5 to 3 mm. The raw iron should be dense, fine-grained, and not too soft. In general, the silicon should be high, 2.3 to 2.7%, phosphorus about 1 to 1.8%, manganese about 0.6%, and sulphur as low as possible. Higher manganese makes iron too brittle. Thorough cleaning of castings by the sandblast without acid treatment is best, followed by dipping in sodium bicarbonate solution (1 to $1^1/_4$ kg. per 100 liters water) and drying in air. The ground coat must be harder than the cover coat, about 70 to 75% SiO_2 being allowable, and must not be overfired. It should not be thoroughly fused in fritting and should be finely ground. The furnace should be at least 950°. A single application of a cover coat containing about 10% tin oxide is best. (*Chem. Abs.*, **10**, 377 (1916); *Chem. and Ind.*, **34**, 1145 (1915).)

Vogel, O.

PICKLING BATH FOR IRON. U. S. Pat. 1,460,395, July 3, 1923.—A pickling bath for iron is formed of sulphuric acid or other acid solution containing about 1% quinoline or one of its derivatives to prevent the metal from becoming brittle. (*Ceram. Abs.*, **2**, 242 (1923).)

Vollkommer, Joseph

FURNACES FOR THE ENAMELING INDUSTRY. *Iron Age*, **82**, 648 (1908).—In the manufacture of small quantities of high grade enamel the crucible should always be used. Fuel consumption is low. Where large quantities of enamel are used a tank furnace similar to that used in the glass industry is employed. Furnaces with direct firing must have large fire places and high bridges to keep the ashes out of the melting pot. The flame should never reach the bath. The coal used should be free from sulphur,

this element tending to cause blisters. Drawings of two tank furnaces are given. For fusing the enamel to metals a muffle furnace must be used. Description and drawings of two such furnaces are given. In firing a furnace with imperfect muffle care must be taken to insure plenty of oxygen in the flame to prevent blistering and discoloration. (*Chem. Abs.*, **2**, 2981 (1908).)

Vollrath, A. J.

ENAMELING IRONWARE. U. S. Pat. 515,507, Feb. 27, 1894.—The process of producing enameled ironware which consists in first applying and fusing upon the ironware a coating of enamel, spattering on the surface to obtain an enamel paste, drying the paste, brushing the surface to remove the enamel from the interior of the spot, and then fusing.

Vollrath, A. J.

MAKING ENAMELED IRONWARE. U. S. Pat. 515,508, Feb. 27, 1894.—The process of producing variegated enameled ironware, which consists in applying to the ware a coating of enamel paste, drying the coating so applied, then applying to the dried coating of enamel patches of figures of enamel paste of contrasting color, and finally fusing in a muffle.

Vollrath, A. J.

ENAMELED IRONWARE AND PROCESS OF ENAMELING. U. S. Pat. 515,981, Mar. 6, 1894. The process of producing ornamental enameled ironware which consists in applying and vitrifying a first coat of enamel of uniform color in the usual manner; then applying over this a second coat of enamel, and while this is still wet sprinkling drops of alcohol upon the wet enamel and thereby washing or removing the wet enamel from the central portion of each drop, thus forming a surrounding ring of intensified color contrasting with both the central removed portion and with the surrounding undisturbed portion, whereby a resemblance of burl knots and bird's-eye of wood is produced, then drying and baking the same.

Vollrath, A. J.

ENAMELING METALLIC SURFACES. U. S. Pat. 564,352, July 21, 1896.—The method of enameling a metallic surface, which consists in applying to the metallic surface a foundation coating of enamel, heating the coated metallic article to a red heat, grinding different-colored enamels to a uniform degree of fineness, sifting the variously-colored enamels upon the heated metallic surface and fixing the enamel by heat.

Vollrath, A. J.

ENAMELING SURFACES. U. S. Pat. 593,792, Nov. 16, 1897.—The process of enameling surfaces, which consists in mixing enamel, ground to an impalpable powder, with water to a state of high dilution, projecting the mixture in a fine spray upon the surface to be enameled, rapidly evaporating the water, by the action of heat, immediately upon its contact with the surface, and then firing.

Vollrath, C. A. W.

EARLY HISTORY OF ENAMELING IN THE VOLLRATH COMPANY. *Jour. Amer. Ceram. Soc.*, **6**, 237 (1923).—Review of the writer's personal experience in enameling, covering a period of fifty years.

Vollrath, C. A. W.

ENAMELING METAL SURFACES. U. S. Pat. 415,485, Nov. 19, 1889.—In the art of enameling metal surfaces, the hereinbefore-named process, consisting of mixing and

melting together the various ingredients of an enamel composition, cooling the same, and grinding the resulting mass to a certain degree of fineness, then separately mixing and melting together similar ingredients with coloring-matter added thereto, cooling the same, and grinding this resulting mass to a different degree of fineness from that to which the first mixture was reduced, then mixing together the two ground products in a moist condition of a pastelike consistency, applying this resulting product to the metal surfaces, and subjecting the goods thus coated to heat in a suitable muffle.

Vollrath, C. A. W.

ENAMEL FOR COATING MACHINE. U. S. Pat. 1,119,905, Dec. 8, 1914.—Finely comminuted colored glass in addition to the ordinary enamel to form a speckled coating. (*Chem. Abs.*, **9**, 239 (1915).)

Vollrath, J. J.

ENAMELING IRONWARE. U. S. Pat. 250,465, Dec. 6, 1881.—The process of enameling and marbleizing metal surfaces consisting of the following steps, viz.: applying a vitreous coating to the metal and firing it thereon, applying a porcelain or enamel composition to the first coating and fixing it by firing, and then applying a tinted enamel composition in a systematic manner, and fixing it by a final firing operation as and for the purpose set forth.

***Vollrath, W. J.**

ZIRCONIA IN ENAMELS. (Discussion.) *Bull. Am. Ceram. Soc.* (this *Bibliography*, p. 41).

Vondracek, R.

CHEMISTRY OF IRON ENAMELING. *Chem.-Ztg.*, **30**, 575 (1906).—The chemical composition of the iron has considerable influence upon the enamel, since the carbon of the iron may reduce the lead compounds of the enamel or cause the formation of carbon monoxide which will blister the coating. This may be avoided either by selecting a chemical composition of the enamel that does not react with the carbon or by preparing the metal surface so that the carbon cannot exert its influence. The former method is not applied to any great extent. White, very fusible lead glasses are applied to red-hot cast iron and form a glassy coating before reduction can take place to any disturbing extent. Also enamels can be used which contain no easily reducible constituents. This is difficult to carry out for a white enamel. The second method consists in applying a neutral ground coating which contains no reducible oxides and is not as fusible as the covering enamel. A good ground composition consists of 29 kg. borax, 50 kg. quartz, 13 kg. feldspar, 4 kg. soda, 3 kg. chalk, 4 kg. bone ash. This mixture is fritted and ground wet, when, for each 13 kg. of the batch, 3 kg. of quartz and 2 kg. clay are added. For stamped ware a ground enamel may be used which is more fusible, owing to the lower content of carbon in the iron and the rapid heating of the thinner ware. Usually this enamel contains 0.5% of cobalt oxide, the latter not being really necessary. A good ground enamel for this purpose consists of 36 kg. borax, 14 kg. quartz, 26 kg. feldspar, 10 kg. soda, 6 kg. potassium nitrate, 0.50 kg. cobalt oxide. In grinding, 1 kg. of clay is added for each 20 kg. of batch. Besides separating the iron from the fused enamel by a ground coating or metallic deposit the injurious effect of the carbon in the iron may be removed by decarbonizing the surface of the iron. This is done by heating the iron in contact with iron oxide, at the same time excluding the air. It is also possible to oxidize the iron-carbon alloy by changing the iron to the oxide. It is necessary in this case that the oxide remain firmly united with the iron

and resist the fusing of the enamel. This procedure is said to be practiced in the United States. The best oxidizing agent was found to be iron oxide, air being admitted. The following enamel composition was found to be suitable: 32 kg. feldspar, 19 kg. borax, 6.5 kg. soda, 2.5 kg. potassium nitrate, 3 kg. fluorspar, 2.5 kg. zinc oxide, 8.5 kg. tin ash, 1.5 kg. bone ash, 1.5 kg. cryolite. A more fusible composition containing lead oxide was found to be composed of 30 kg. feldspar, 6 kg. quartz, 21 kg. borax, 13 kg. soda, 3 kg. potassium nitrate, 10 kg. minium, 4 kg. cryolite, 10 kg. tin ash. (*Chem. Abs.*, **1,** 89 (1907).)

Vondracek, R.

ENAMELING OF IRON. *Sprechsaal*, **41,** 475, 493, 507 (1908).—The enameling of metal, owing to its greater contraction, is more difficult than the enameling of clayware. Breidenstein has constructed an instrument for measuring the difference in contraction between metal and glaze (Ger. Pat. 181,556). The iron used for enameling need not be very pure, but at the temperature 800° to 1000°C, enamels containing tin, lead, antimony, or zinc would be reduced by the carbon in the iron, and the evolution of carbon dioxide would cause "bubbling." Steel or wrought iron is better for use than cast iron. The amount of silicon in the iron should be as small as possible as it causes the carbon to separate in leaflets which are difficult to remove from the surface of the metal and lead to the formation of holes. As flux, 1 kilo of feldspar, 1.5 kilos of borax, and 0.25 kilo of cryolite are used for each ton of iron. The carbon in the surface layer of the iron is burnt out with the aid of oxidizing agents. According to various patents, chlorate, nitrate, manganese dioxide, or red lead have been proposed. Sodium carbonate has also been recommended; by its use silicon, sulphur, and phosphorus are also removed. Or, again, the metal is dipped in 25% sulphuric acid, whereby a layer of iron sulphate is formed, which oxidizes the carbon on heating. The carbon can also be removed by regulating the composition of the fire-gases in burning, according to the reversible reactions: $Fe + CO_2 \rightleftarrows FeO + CO$, and $CO_2 + C \rightleftarrows 2CO$. At 550°, the first reaction gives 64% by weight of carbon monoxide and 36 of carbon dioxide; at 900° C the ratio is 71.5:28.5. If, therefore, the proportion of carbon dioxide be greater than in these ratios, the iron will be oxidized. The cleaning of the metal surface for taking of the enamel is performed by "pickling" or by means of a sandblast, or electrolytically. The pickling is effected by sulphuric acid, or by commercial sodium sulphate, which contains 1.5% of free acid. Hydrofluoric acid (2 to 10%) is recommended, as it removes sand and rust without attacking the metal, and the process is finished in 15 minutes. After pickling, the metal is washed with water or with a dilute solution of sodium carbonate. In the electrolytic process, sodium sulphate is used as electrolyte and the iron as cathode. Owing to the formation of the hydroxide of the metal as by-product, this method is said to be the cheapest. Before enameling, an "undercoat" is deposited to prevent action between the metal and enamel, and to obtain good adhesion. The undercoat may be of siliceous material, or of some suitable metal (cobalt, nickel, copper, aluminium, gold) which is often deposited electrolytically. Metallic undercoats, however, are liable to come off in the firing of the enamel. Siliceous undercoats may be caused to adhere to the metal before firing by deposition from solutions of acids, alkalis, or gums. The composition of a good undercoat is: 1.0 R_2O, 0.5 to 0.6 B_2O_3, 4.0 to 6.4 SiO_2. The enamel itself may contain 35 to 40% of silica, and 6 to 10% of boric anhydride, with opaque material. (*Chem. and Ind.*, **27,** 1020 (1908).)

Vondracek, R.

ENAMEL INDUSTRY. *Sprechsaal*, **44,** 264 (1911); through *Chem. Zentr.*, **1,** 1896 (1911).—A general review of the industry for 1910. (*Chem. Abs.*, **5,** 3503 (1911).)

Vondracek, R.

FUNCTION OF GROUND ENAMEL. *Sprechsaal*, **44**, 115 (1911).—The ground enamel is necessary to prevent the oxidation of the carbon in the iron as well as that of the latter. V. does not agree with Mayer and Havas who claim that the iron reduces the tin oxide to tin and that hence the ground prevents contact between the iron and the enamel proper. (*Chem. Abs.*, **5**, 2163 (1911).)

Vondracek, R.

COVERING POWER OF CLOUDING ENAMELS. *Sprechsaal*, **47**, 34 (1914).—Water and alkali containing forms of the oxides of tin, zirconium, and titanium are used. The increased covering properties are probably due to the oxides being in a state of a colloidal gel, the water being absorbed. This hypothesis explains also the fact that the presence of alkali may be injurious to the covering power of SnO_2, when the latter has been "dead-burnt," in which case it loses its power of absorption and gel formation. This new product might contain, for example, 3% Na_2O and 10% water. (*Chem. Abs.*, **8**, 3493 (1914); *Chem. and Ind.*, **33**, 647 (1914).)

Vulkanit-Werke

PREPARATION OF AN ENAMEL FOR METALS. German Pat. 404,442, July 10, 1923.—Part of the usual enamel constituents (quartz, feldspar, and soda) are replaced by pumice or similar material. The resulting enamels may be used either as ground coats or cover enamels for metals. (*Chem. and Ind.*, **44B**, 208 (1925).)

***Wade, W.**

CONTINUOUS MUFFLE FURNACES OR KILNS. See Dicken, W. (this *Bibliography*, p. 95).

de Waele, A.

VISCOMETRY AND PLASTOMETRY. *J. Oil and Color Chem. Assn.*, **6**, 33 (1923).—A discussion of viscous flow, kinetic energy correction, slippage, turbulence, and effects, etc., as applied to viscosity measurements with capillaries. The plastometer used embodies the usual principles of efflux viscometers except that higher pressures of shear than can conveniently be obtained by a head of liquid are obtained by air pressure. The apparatus is described in detail, and results are plotted and tabulated. These indicate that the work of Bingham, Green, and others (*C. A.*, **14**, 1047; **16**, 2447) has been based on an insecure foundation in that curvature of the relationship between pressure and volume of flow per unit time has been interpreted as slippage; this resulted from their failure to explore the P/Q relationship at sufficiently high rates of shear and from confining their attention to substances of low plasticity. A direct mathematical disproof is derived of the validity of the relationship expressing Bingham's law of plastic flow. The analogy between plastic bodies and liquids is shown by simple relationships of the equations of shear. Discussion and correspondence follows. Bingham and Green wholly disagree with de W.'s conclusions and formula. (*Ceram. Abs.*, **4**, 91 (1925).)

de Waele, A.

Koll. Zeit., **36**, 332(1924).

Wagner, Bruce F.

PREPARATION OF STEEL FOR PICKLING. *Enamelist*, **5**, [1], 24 (1927).—Steel may be prepared for pickling by (1) annealing, (2) acid annealing, and (3) chemical cleaners. Acid annealing is advantageous for cooking ware or utensils because the oil is spun into the pores in such a way that it is practically impossible to remove it by use of chemical cleaners.

Wagner, C.

PRODUCING AN ENAMEL COATING ON VESSELS, ETC. German Pat. 321,480, April 12, 1919.—A mixture of borax, bronzite, and black copper oxide applied to the surface of the vessels gives on firing a crystalline bronze appearance of red, yellow, or green color. (*Chem. and Ind.*, **39A**, 690 (1920).)

***Wagner, R.**

ENAMELING IRON. See Hermsdorf, L. (this *Bibliography*, p. 152).

Wagner, R. F.

ENAMELING IRON OBJECTS. French Pat. 356,736, Aug. 7, 1905; British Pat. 17,292, Aug. 26, 1905.—This process for enameling iron objects is based on the employment of an alkaline-earth phosphate, in order to increase the refractory properties of the enamel and to render it opaque. Mixtures of enamels containing phosphoric acid with enamels containing alkaline-earth compounds are baked in order to bring about the formation of alkaline-earth phosphates during the baking. (*Chem. and Ind.*, **25**, 21 (1906).)

Wagner, R. F.

ENAMELING IRONWARE. German Pat. 179,440, Feb. 1, 1905.—Process of enameling ironware with alkaline earth phosphates with a view to securing fire resistance and producing by firing a lasting cloudiness of the enamel, consisting in firing mixtures of difficultly fusible glasses which contain calcium, strontium, or barium phosphate, or several of them, with readily fusible silicate glasses, the latter serving as a fluid glass and flux, while the difficultly fusible phosphate glasses render the glass thick during the firing and produce a strong, lasting cloudiness. The barium silicate glasses should contain a considerable quantity of aluminum fluoride, argillaceous earth, or both. (*Chem. Abs.*, **1**, 2201 (1907).)

Wagret, P.

MANUFACTURE OF VITRIFIABLE ENAMELS. French Pat. 367,613, April 12, 1906.—The vitrifiable enamels are produced by the employment of the following materials: *Red:* minium, Paris red, gray earth, borax. *Black:* indigo blue. *White:* fluorspar. (*Chem. and Ind.*, **25**, 1147 (1906).)

Wahlin, Joel G.

BACTERIAL GROWTH IN ENAMEL SLIP. *Jour. Amer. Ceram. Soc.*, **7**, 160 (1924).—(1) Enamel slip is not sterile as evinced by the isolation of two different micro-organisms from a sample. (2) One of these organisms is capable of producing gas in the enamel slip by decomposing nitrates present. (3) A strong alkaline reaction is necessary for growth and denitrification by the organism. (4) Metallic ions exert an influence on the rate of denitrification but are accessory rather than indispensable to the process as well as growth of the cell. (5) There is no symbiotic relationship between the two organisms studied. (*Chem. Abs.* **18**, 1888 (1924); *Chem. and Ind.*, **43B**, 382 (1924).)

Waldes and Co.

ENAMELING TOOLS, ETC. German Pat. 242,850, Jan. 29, 1911.—Immerse them in water, sprinkle the powdered enamel substance upon the surface of the water, withdraw the tool (whereby the enamel powder adheres to its surface), and fire in a suitable furnace. (*Chem. Abs.*, **6**, 2157 (1912).)

Walters, W., and Smith, C. A.

MACHINERY FOR DISTRIBUTING ENAMELING POWDERS. U. S. Pat. 454,312, June 16, 1891.—The combination with the table and the rails, of a series of powder-distributing hoppers carried by the rails, and a single driving-shaft common to all the hoppers and adapted to traverse them simultaneously and synchronously upon the rails.

Walton

ENAMELING OVEN. *Civ. eng.*, p. 355 (1847); *Lond. j.c.s.*, **31,** 184; *Dingler's polyt. Jour.*, **106,** 362.—(*Rep. der Tech. Lit.*, p. 272 (1823–1853).)

Warga, K.

ENAMELED METAL ARTICLES. British Pat. 116,361, June 11, 1917.—A vitreous enamel is applied to a sheet of Al or Al-containing metal and the article is subsequently shaped from the enamel sheet by bending, stamping, etc. Suitable enamels consist of mixtures of SiO_2, $Na_2B_4O_7$, and red lead, or SiO_2, red lead, and oxide of Bi. The enamel may be applied mixed with varnish, etc., sprinkled upon a varnish layer, or upon the heated material. Pigments may be added and filling such as metal or metal salts may be mingled with the enamel. (*Chem. Abs.*, **13,** 79 (1919); *Chem. and Ind.*, **37A,** 418 (1918).)

Warga, K.

ENAMELING. British Pat. 191,771, Aug. 16, 1921.—Multicolor decorations, designs, lettering, etc., are printed on surfaces of aluminum or aluminum alloy and enameled. Films comprising mixtures of mineral colors or pigments and vitreous flux with a liquid or viscous vehicle are printed successively on the metal surface, the melting points of the mixtures being so arranged that the mixture adjacent the metal surface has the lowest melting point and the melting points of the successive films rise progressively. The metal surface is oxidized prior to printing and the films are fixed by firing in a kiln in which a temperature corresponding to the highest melting point is maintained. (*Ceram. Abs.*, **2,** 274 (1923); *Chem. Abs.*, **17,** 3238 (1923); *Chem. and Ind.*, **42A,** 270 (1923).)

Warga, K.

COATING ALUMINUM WITH VITREOUS ENAMEL. U. S. Pat. 1,230,958, June 26, 1917.—Aluminum or an aluminum alloy is coated with finely powdered glass or other vitreous material and the latter is then fused upon the surface to form an adherent flexible coating. (*Chem. Abs.*, **11,** 2323 (1917).)

Watermann, C. H.

ENAMELING THE SURFACE OF REFRACTORY MATERIALS. British Pat. 5204, May 12, 1901.—The apparatus consists of an electric heater of large superficial area, and of means for presenting the material to be enameled in a plane parallel and in close proximity to the heater, so that the entire surface of the material will be heated simultaneously, immediately, and uniformly, a nonoxidizable shield being interposed between the heater and the material in order to protect the enamel from contamination by contact with emanations from the heater. (*Chem. and Ind.*, **20,** 581 (1901).)

Watermann, Charles H.

PROCESS OF ENAMELING. U. S. Pat. 640,844, Jan. 9, 1900.—The process herein set forth of flashing enamel onto surfaces of a refractory material, which consists in applying the enameling material to the desired surface, and subjecting such surface to the action of uniform electric heat delivered at once on and over the entire coated

surface in a plane parallel thereto, whereby all the enameling material is instantaneously and simultaneously fused over the whole surface to which it is applied while the body of the article is left relatively cool.

Watermann, Charles H.

ENAMELING SURFACES OF REFRACTORY MATERIAL. U. S. Pat. 669,567, March 12, 1901.—In apparatus for flashing enamel upon the surface of refractory material, the combination of an electrical converter having a broad heating surface and mechanism, or presenting a surface of refractory material in a plane parallel to the heating surface in proximity thereto but out of contact therewith, whereby the enamel is immediately fused to the surface of refractory material upon which it is imposed by a uniform degree of electrical heat applied simultaneously and instantaneously over all parts of the enamel.

Watkins, E. H.

VARIATION OF 3% SILICA OXIDE CONTENT IN FELDSPAR WILL CAUSE WIDE VARIATION IN WORKABILITY OF PORCELAIN ENAMEL. *Enamelist* **2** [4], 17 (1925).—Calculations are used to show that by using a feldspar in which the silica is 3% more than the theoretical silica content for feldspar, means that 8.55% more of free silica is added.

***Watson, J. A.**

COATING ALUMINUM OR MAGNESIUM OR THEIR ALLOYS WITH SILICATES. See Daniels, S. (this *Bibliography*, p. 78).

Weaver, J. C.

HISTORY AND IMPROVEMENT OF FURNACE BARS. *Bull. Amer. Ceram. Soc.*, **6**, 308 (1927).—A discussion of the equipment used in enamel firing, including bars, pins, hanging racks, and double deckers. (*Ceram. Abs.*, **6**, 567 (1927).)

Weaver, J. C.

HINTS ON PICKLING. *Enamelist*, **2** [9], 25 (1925).—Recommendations: (1) good equipment (should be acid resisting); (2) choice of acid depends upon articles to be pickled; (3) in most cases 4 to 6% sulphuric acid will pickle properly; (4) temperature should be about 140°F; (5) agitation is advantageous; (6) concentration of acid should be controlled.

Weaver, R. A.

LOADING AND UNLOADING ENAMELING FURNACES. U. S. Pat. 1,559,591, Nov. 3, 1925. In apparatus for loading and unloading enameling furnaces, the combination of a charging fork adapted to be moved into and out of the furnace to load and unload the furnace, and a transfer table adapted to be loaded with the work to be deposited in the furnace, the transfer table being adapted to be moved transversely across the path of movement of the charging fork, the charging fork being adapted to carry suitable racks for supporting the work in the furnace, and the transfer table being adapted to support the load directly over the racks carried by the charging fork, the charging fork being adapted to be raised and to thereby lift the work from the transfer table to the racks on the charging fork, and the transfer table being adapted to be removed out of its position in the path of the charging fork. (*Ceram. Abs.*, **5**, 15 (1926).)

Weaver, R. A.

FIRING RACK. U. S. Pat. 1,610,111, Dec. 7, 1926. A firing rack including space bars and cross-pieces slidably mounted upon the bars. (*Ceram. Abs.*, **6**, 51 (1927).)

Weaver, R. A.

HISTORY OF PORCELAIN ENAMELING FURNACES IN THIS COUNTRY. *Fuels and Fur.*, **4**, 220 (1926).—The history of enameling furnaces has followed the history of the porcelain enamel business. From the first the enameler has favored the muffle type of furnace, but it was difficult in the early days to get enduring muffles. The development of enameling furnaces is closely connected with the design of the fork used and the type of material from which it was made. Most of the original furnaces were fired with coal. Later oil and natural gas were used and recently electric furnaces have been operated with considerable success. Muffles made from new materials produced for the enameling industry in recent years have aided the enameler in increasing his production and lowering his costs. (*Ceram. Abs.*, **5**, 142 (1926); *Enamelist*, **3** [6], 10 (1926).)

Weber, J.

OPAQUING COMPOSITION FOR USE IN VITREOUS ENAMELS. U. S. Pat. 1,150,467, Aug. 17, 1915. Hydrated stannic oxide containing about 10% water and 3 to 5% of alkali. See French Patent 439,609 of 1912. (*Chem. Abs.*, **9**, 2701 (1915); *Chem. and Ind.*, **31**, 723 (1912); *ibid.*, **34**, 963 (1915).)

Weber, J.

COLORING ENAMELS. U. S. Pat. 1,181,944, May 2, 1916.—Neutralized anhydrous calcium stannate is used as an opaque coloring material in the enamel. (*Chem. Abs.*, **10**, 1701 (1916); *Chem. and Ind.*, **35**, 691 (1916).)

Webster, D. H.

USE OF METAL, ENAMELED, AND PORCELAIN VESSELS IN MANUFACTURING PHARMACEUTICAL PREPARATIONS. *Arch. Pharm.* **262**, 575 (1924); *Chem. and Ind.*, **44B**, 189 (1925).—Plates of various materials were boiled with four pharmaceutical liquors and with normal NaOH and H_2SO_4. Porcelain was the best, and enameled metal the worst; resistant materials intermediate in order were: Krupp's Nirostastahl V2A; German silver; copper, brass, tombak, and phosphor-bronze (these four being approximately equally liable to attack), aluminum, and tin. (*Ceram. Abs.*, **4**, 155 (1925).)

Wecker, J.

CHANGE IN VOLUME OF PIG IRON ON MELTING. See Sauerwald, F. (this *Bibliography*, p. 266).

Wedemeyer, O.

CRYSTALLIZATION OF COMBINED CARBON IN CAST IRON: INFLUENCE OF PROLONGED HEATING. *Stahl u. Eisen*, **46**, 557 (1926).—Prolonged heating at temperatures below 1500°C increases carbide content of cast iron. The increase is much more marked in cast iron made from soft irons than in that made from hematite iron. Thus, overheating for three hours at 1295°C increased the combined carbon in the soft iron from 1.12 to 2.57%, and in the other only from 0.8 to 1.00%. (*Ceram. Abs.*, **5**, 299 (1926); *Chem. and Ind.*, **45B**, 544 (1926).)

Weigel, W. M.

SPECIAL SANDS. *Ceramist* **5**, 177 (1924).—Portions of interest to ceramists of Bur. Mines, Repts. of Inves., No. 2615, "Sandblast Sand," and No. 2622, "Filter Sand for Municipal Water Supply" (1924). (*Ceram. Abs.*, **4**, 299 (1925).)

Weigel, W. M.

SANDBLAST SAND. *Nat. Glass Budget*, **42**, 11 (1926).—Definitions of sand are discussed. Sandblast sand requires most uniformly sized grains. Uses of the sandblast and classifications of different sizes of sandblast sand are discussed together

with the relative merits of rounded grains and sharp, angular grains. (*Ceram. Abs.*, **5**, 268 (1926).)

Weil, Edgar H.

PROCESS OF ENAMELING. U. S. Pat. 1,603,368, Oct. 19, 1926.—The process of vitrifying enamel on a substantially flat article having broad faces, which comprises supporting the article substantially vertically, and subjecting the opposite faces of the article substantially uniformly to radiant heat to thereby substantially uniformly heat the article and vitrify the enamel thereon. (*Ceram. Abs.*, **5**, 385 (1926); *Chem. Abs.*, **21**, 164 (1927).)

Weimer, L. S.

APPARATUS THAT HAS IMPROVED ENAMEL. *Bull. Amer. Ceram. Soc.*, **6**, 233 (1927).—Raw materials taken from the bins are dumped into a mechanical mixer, then run into a bucket which carries them to rotary smelters by trolley. The frit is milled to uniform fineness by direct-connected mills. The enamel is accurately weighed for dipping and fired for a specified time controlled by an automatic timer. Then transfer work is done using an electric oven for drying. (*Ceram. Abs.*, **6**, 453 (1927).)

Weimer, L. S.

BLOWERS CUT FUEL COST 25%. *Ceram. Ind.*, **8**, 212 (1927).—A description of the enameling plant of the Malleable Iron Range Co. (*Ceram. Abs.*, **6**, 133 (1927).)

Weimer, L. S.

ELECTRICAL OVEN FOR APPLYING AND DRYING DECALCOMANIAS. *Enamelist*, **3** [1], 7 (1925).—In order to eliminate defects the following methods were tried: (1) An oil-fired steel shell muffle oven was built. This gave fairly good results, but it was difficult to maintain the proper temperature, the enamel also had to be loaded on iron trucks to run in this oven; it was thus exposed to more or less dust and dirt. (2) A steam coil was then tried. This was somewhat cleaner, but as the temperature was limited to the heat of the steam, this was quite slow often taking from ten to twelve hours to properly dry a load. (3) A gas-fired full muffle oven was tried. This gave the best results when compared with any previous method, but had some of the faults of the other methods. (4) A transfer room and electric oven were then built. This has given excellent results and seems to approach the ideal condition. A sketch is given showing the working arrangement of the electrical systems. The superior qualities of this system are numerated.

Weimer, L. S.

PYROMETERS FOR VITREOUS ENAMELING. *Enamelist*, **3** [5], 5 (1926).—The use of pyrometers will eliminate many variable conditions as to the correct firing temperature. Charts are shown to illustrate the use of a recording pyrometer.

Weimer, Rudolph

SUBSTITUTE FOR TIN OXIDE FOR ENAMELING METALWARE. U. S. Pat. 932,839, Aug. 31, 1909.—The boiled, roasted, and ground product of Sb oxide 70, NaOH 28, $NaNO_3$ 22, kaolin 10, and barytes 10 parts. (*Chem. Abs.*, **3**, 2554 (1909); *Chem. and Ind.*, **28**, 1036 (1909).)

Weimer, Rudolph

HOW TO OBTAIN AN ENAMEL TO SUIT YOUR PURPOSE. *Ceram. Ind.*, **5**, 350 (1925).—This article contains methods used by Froelich, the eminent German enameler. W.

compares enamel compositions to Jena glass. The enamel compositions are divided into refractory and fluxes. It is shown within what limits the composition of the Jena glass may be varied, in order to obtain ground coats and cover coats without altering the expansion coefficient. (*Ceram. Abs.*, **5**, 11 (1926).)

Weimer, Rudolph

HOW YOU CAN FIT ANY COVER COAT TO A GROUND COAT. *Ceram. Ind.*, **5**, 425 (1925).—W. gives extensive tables made up by R. Froelich, showing the composition of ground and cover enamels in which the ingredients have been so adjusted that the coefficient of expansion between the sheet steel or iron and the ground coat and between the ground coat and the cover coat have been brought into close harmony with each other. An explanation of the variation of the ingredients is given. (*Ceram. Abs.*, **5**, 11 (1926).)

Weimer, Rudolph

EFFECTS OF BLENDING GROUND COATS. *Ceram. Ind.*, **6**, 375 (1926).—A cover coat must have a lower fusion temperature than its ground coat. The melting point and elasticity factor of the ground coat must be in harmony with the sheet metal and the cover coat. The ground coat must fuse to the metal and the cover coat to the ground coat. The fluxes in the cover coat should be 2 to 3% higher than in the ground coat. The mill addition of clay and tin oxide reduces the flux content of the cover coat. The metallic oxide of the ground coat must not be so high as to fire through the cover coat. It is best to have several ground coats of varying composition which may be blended to have the desired properties. Zinc oxide gives an enamel frit resistancy, durability, strength, fire resistance, and luster, and is claimed to be nonpoisonous. (*Ceram. Abs.*, **5**, 176 (1926).)

Weiss, L.

OPAQUE OR TURBID GLAZES. *Céramique*, **17**, 2 (1914).—The use of basic and double fluorides as opacifiers is recommended. Less material is required to produce a given result than with oxides of tin, antimony, titanium, zirconium, etc. (*Chem. Abs.*, **8**, 3226 (1914).)

Weiss, L.

OPAQUING AGENTS FOR ENAMELS. French Pat. 459,999, June 23, 1913; British Pat. 14,632, June 24, 1913.—Fluorides or double fluorides of tin, antimony, titanium, zirconium are used. The effect is increased by the presence of hydroxides of the alkalis and alkaline earths or of silicon compounds. The separations caused by steam and alkali or alkaline earth hydroxides from frit-soluble fluorides, and double fluorides of antimony, titanium, and zirconium are characterized by the finest division while the free fluorine lowers the temperature of decomposition so that the amount of water present after drying is sufficient. (*Chem. Abs.*, **8**, 2932 (1914); *ibid.*, **9**, 136 (1915); *Chem. and Ind.*, **32**, 1157 (1913).)

Weiss, Ludwig

ZIRCONIUM OXIDE AS A CLOUDING AGENT IN ENAMELS AND GLASSES. *Z. anorg. Chem.*, **67**, 456.—Reply to Hillringhaus and Heilmann, *Z. anorg. Chem.*, **66**, 436. W. admits his omission of the mention of D. R. P. 189,364, but claims to have done so intentionally and promises a fuller explanation in another paper. See this *Bibliography*, p. 154. (*Chem. Abs.*, **5**, 168 (1911).)

Welte, H.

SUPPORT FOR GALVANIC PRODUCTIONS OF PATTERNS IN CERAMIC AND ENAMEL INDUSTRIES. German Pat. 283,081, Jan. 17, 1914. (*Chem. Abs.*, **9**, 2444 (1915).)

Wenning, W. F.

RÔLE OF ZIRCON IN PREVENTION OF FISHSCALE. *Ceram. Ind.*, **6**, 43 (1926).—Methods of fishscale prevention: (1) uniform frit composition and homogeneous or correctly smelted enamels; (2) correct coefficient of expansion and high tensile strength of enamel; (3) use of best grades of enameling iron; (4) proper choice of clay; (5) pickling process should allow only the absolute minimum amount of soluble salts to remain in iron; (6) eliminating the occluded gases by keeping the ground coat porous during firing at temperatures from 1000 to 1500°F. The addition of 1 to 3% of zirconia ore to the mill will permit occluded gases to free themselves from the iron because (1) the porous condition of this mineral allows the gases to diffuse through the ground coat, and (2) at higher temperatures (1400 to 1600°F) formation of sodium zirconate, a porous substance during the formation, allows remaining gases to free themselves.

Wenning, W. F.

ZIRCONIA IN SHEET-IRON ENAMELS. *Bull. Amer. Ceram. Soc.*, **2**, 102 (1923); *Jour. Soc. Glass Tech.*, **7**, 241 (1923).—The zirconia was used in place of Al_2O_3 and SiO_2 in ordinary ground enamels. A replacement up to 10% by zirconia in the batch changed the working properties of the enamels very little, but large replacements rendered the enamel very viscous and difficult to melt down. Enamels containing up to 10% of zirconia were stronger and more elastic. The chief virtue of zirconia was its opacifying property. White, amorphous zirconia, used as a batch ingredient to replace SiO_2, Al_2O_3, ZnO, Sb_2O_3, SnO_2, and phosphates, gave denser and purer enamels. When used in mill formulas of low-fluoride enamels, zirconia produced exceptionally good opacity and whiteness. Enamels containing zirconia were more acid-resistant and also more resistant to mechanical and thermal shock than enamels without zirconia. Discussion of this paper by H. C. Arnold, E. P. Poste, W. J. Vollrath, H. F. Staley, F. R. Glenner, B. A. Rice, F. J. Jaeger, J. A. Aupperle, M. E. Manson, R. R. Danielson, L. J. Munroe, and R. D. Landrum. *Bull. Amer. Ceram. Soc.*, **2**, 303 (1923) (this *Bibliography*, p. 41). (*Enamelist*, **1** [1], 10 (1923); *Chem. Abs.*, **18**, 2589 (1924).)

***Wenning, W. F.**

ZIRCONIA IN ENAMEL. (Discussion.) See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 41).

Wenz

ENAMEL APPARATUS AND ITS USE. *Chem. App.*, **11**, 89 (1924). (*Ceram. Abs.*, **3**, 313 (1924).)

Werty, H. W.

HISTORY OF OIL BURNING. *Enamelist*, **2** [2], 17 (1924).—Oil was first used in Russia as a fuel. Device invented by Werner, employed in a Russian refinery, 1861, was used to burn the oil which trickled over grates. First American patents, 1862, by Shaw and Linton, used the oil in gaseous state. First spray burner introduced in America by Brydges Adams in 1863. Aydon, Wise, and Field introduced first nozzle feeder in London in 1865. Spakovsky, Russian, used hot blast of air to atomize the oil in 1865. In 1870, another Russian perfected a burner to use heavy refuse oil. In 1878, another type of the oozing furnace was brought out in New Jersey. Since 1883 the progress has been much more rapid.

West, C. J.

UNITED STATES PATENTS RELATING TO ENAMELS WITH SPECIAL REFERENCE TO ENAMELS FOR IRON AND STEEL. *Jour. Amer. Ceram. Soc.*, **3**, 893 (1920).—Abstracts of these patents are included in this work. (*Chem. Abs.*, **15**, 426 (1921).)

West, C. J.

READING LIST ON VITREOUS ENAMELING ON IRON AND STEEL. *Jour. Amer. Ceram. Soc.*, **4**, 47 (1921).—List of reference books and journal publications on enameling. Journal references have been included in these abstracts. Book References: (1) Keramische Rechentaflen zum Gebrauch in den Laboratorien der Ton-, Glas- und Email Industrie. H. Bollenbach. Halle: W. Knapp, 105 pp. (2) Art of Enameling. 2nd Edition. 1914. W. N. Brown. London: Scott, Greenwood and Son, 58 pp. (3) How to Enamel. H. M. Chapin. Wiley, 1911. (4) Enameling, L. F. Day. Scribner, 1908. (5) Emaillenindustrie. Dresden, IV, 255 pp. (6) Analgen und Emrichtungen e. Emaillewerke. Ph. Eyer. Berlin: Keram. Rundschau, 44 pp. (7) Emaille-Wissenschaft. In gemeinverstandl Auslegung. Ph. Eyer. Dresden: Verlag "Die Glashutte," 224 pp. (8) Art of Enameling upon Metals. A. Fisher. 1906, Lane, 38 pp., 26 plates. (9) La fabrication industrielle des emaux et couleurs ceramiques. L. Franchet, 1911. (10) Practical Enameler. O. Grampp, 1909. William. (11) Clay Glazes and Enamels, with Supplement on Crazing, Its Causes and Prevention. H. R. Griffin, 1913. Randall and Co. (12) La technique de l'émaillere moderne. J. Grünwald. Paris: H. Dunod et Pinat. (13) Raw Materials for the Enamel Industry and Their Technical Technology. J. Grünwald. Translated from the German by H. H. Hodgson, 1914. London: C. Griffin and Co., VIII, 225 pp. (14) Technology of Iron Enameling and Tinning. J. Grünwald, 1912. London: C. Griffin and Co., 138 pp. (15) Theory and Practice of Enameling on Iron and Steel with Historical Notes on the Use of Enamels. Translated by H. H. Hodgson. J. Grünwald, 1910. London: C. Griffin and Co., VII, 131 pp. (16) Über Eisenblechemaille. (Dissertation of the Tech. Hochschule zu Karlsruhe.) B. Havas, 1910. (17) Enamels. R. D. Landrum, 1918. Cleveland: Harshaw Fuller and Goodwin Co., 106 pp. (18) Manuel pratique de l'émaillage sur metaux. L. Millenet, 1917. (19) Metal Work and Enameling. H. Maryon, 1913. London: Chapman and Hall, 342 pp. (20) Enamels for Sheet Iron and Steel. J. B. Shaw, 1920. Washington: U. S. Bureau of Standards, *Tech. Paper*, No. 165, 88 pp. (21) Materials and Methods Used in the Manufacture of Enameled Cast-Iron Ware. H. F. Staley, 1919. Washington: U. S. Bureau of Standards, *Tech. Paper*, No. 142, 158 pp. (22) Transfer Printing on Enamels, Porcelain, and Pottery. Wm. Turner. (*Chem. Abs.*, **15**, 2345; *Chem. and Ind.*, **40B**, 129 (1921).)

Westfalische Stanz-und Emailliewerke Akt. Ges. vorm. J., and H. Kerkamm

ENAMEL GLAZES ON IRON. German Pat. 289,103, Sept. 11, 1913.—Metal powder or dust is added to the ordinary enamel glaze. Powdered copper, nickel, bronze, cobalt, etc., are specified as suitable, *e.g.*, about 10% copper powder is added to a glass flux, such as soft boron glass; this enamel is applied to the steel surface or the like, and fired in at 800 to 1200°. The metallic particles come into immediate contact with the metallic surface, and are welded thereto. (*Chem. Abs.*, **10**, 2511 (1916); *Chem. and Ind.*, **35**, 424 (1916).)

Westfalische Stanz-und Emailliewerke Akt.-Ges. vorm. J., and H. Kerkamm

ENAMEL GLAZES ON IRON. German Pat. 290,054, Nov. 4, 1913; Addition to 298, 103.—Water soluble metallic compounds which decompose at the enameling temperature

are added to the composition in the present process. Such compounds are the nitrates and sulphates, as $AgNO_3$ and $CoSO_4$. By reason of the solubility of these compounds, the metallic constituents of the enamel mixture are more uniformly distributed than is the powder. The metal compounds are mixed with the solution or the suspension of the enamel constituents. The composition is then applied to the articles to be enameled in the usual manner, and fired in at a high temperature. During the firing the metallic compounds decompose in such manner that the metals separate while the other components of the compound volatilize or form compounds with other constituents of the enamel composition. The metallic particles which have separated act then in the same manner as the metal powder in the principal process. Those particles which come in contact with the sheet under treatment are welded therewith. (*Chem. Abs.*, **10**, 2792 (1916); *Chem. and Ind.*, **35**, 541 (1916).)

Wever, F.

ALLOTROPY OF IRON. *Stahl u. Eisen*, **45**, 1208 (1925).—Elements alloying with iron may be divided into two classes: (1) those that increase the stability of the face-centered γ lattice, such as carbon, nickel, and manganese, and (2) those that increase the stability of the space-centered α-phase, such as Sn, Si, W, and Mo. Westgren established by X-rays that there are only two polymorphic phases of iron, the cubic space-centered lattice below 900° and above 1400°, and the cubic face-centered lattice between 900° and 1400°. (*Ceram. Abs.*, **5**, 13 (1926); *Chem. and Ind.*, **44B**, 721 (1925).)

***Whitford, L. G.**

PAPERS ON ENAMELING BEFORE THE CHICAGO SECTION, AMERICAN CERAMIC SOCIETY. See *Chem. Met. Eng.* (this *Bibliography*, p. 65).

***Whiting, J. C.**

ENAMELING METALWARE. See Quimby, E. C. (this *Bibliography*, p. 252).

INNOVATION IN THE MANUFACTURE OF ENAMELED IRONWARE. See Quimby, E. C. (this *Bibliography*, p. 252).

Whitmore, J. B., and Ferguson, J. E.

METHOD AND MACHINE FOR ENAMELING BOWLS. U. S. Pat. 1,547,704, July 28, 1925.—In a machine for coating an object, the combination of a support for the object, a material dispersing device, means for oscillating device in a given arc, means for regulating the sweep of arc to guide the dispensed material onto a given arc of the object.

Whittaker, Harold F., and Baker, Theodore

ENAMELED WARE. U. S. Pat. 1,496,505, June 3, 1924. In the method of making chemical-resistant enameled ware having a metallic base, the step which comprises incorporating in the base material a metal capable of rendering the coefficient of expansion of the metallic base substantially the same as the coefficient of expansion of the enamel component of the ware, shaping the base material into the desired form, and applying thereto the enamel. As a new article of manufacture, enameled ware having a metallic base and comprising an enamel having high chemical resistance and a relatively low coefficient of expansion, and a metallic base consisting of an alloy whose coefficient of expansion is substantially the same as that of the enamel. As a new article of manufacture, an enameled iron alloy comprising an enamel whose components are present in the following proportions: SiO_2, 67.0 to 75.0%; B_2O_3, 4.0 to 24.0%; Na_2O, 4.0 to 8.5%; K_2O, 0.2 to 1.3%; CaO, 0.2 to 7.0%; MgO, 0.0 to 0.5%; Al_2O_3,

0.0 to 10.0%; PbO, 0.0 to 1.0%; and an alloy having substantially the same coefficient of expansion as the enamel and containing between 50 and 68% of iron and between 43 and 32% of nickel. (*Ceram. Abs.*, **3**, 241 (1924); *Chem. and Ind.*, **44B**, 995 (1925).)

Whittier, Horace R.

GAS IN ENAMELING. *Enamelist*, **4** [6], 10 (1927).—Gas is used by the H. R. Whittier Co. This company manufactures dials, name plates, and any other article upon which directions, scales, or half-tones may be reproduced.

Wieck's Gwz., p. 268 (1861).

ENAMELING CAST-IRON VESSELS. *Rep. der Tech. Lit.*, p. 306 (1854–1868).)

Wieck's Gwz., p. 135 (1869).

ENGLISH METHOD OF ENAMELING IRON VESSELS. (*Rep. der Tech. Lit.*, p. 405, (1869–1873).)

Wiester, Stefan

AIR-COOLED VS. WATER-QUENCHED ENAMELS. *Jour. Amer. Ceram. Soc.*, **6**, 973 (1923).—Tests were run on an enamel, one-half of which had been quenched in water while the other half had been air cooled. In the experiments the air-cooled enamel did not blister while the water-quenched portion did, and the air-cooled portion gave a smoother surface with better opacity and gloss than did the water-quenched enamel. To cool enamels by compressed air for dry process a longer spout must be used so as to give the enamel some chill before putting under air pressure. The enamels will then stay in fine threads by regulated air pressure. Otherwise the enamel will get too fine. The enamel can be blown into a continuous mill and stored in powdered form, thus saving the handling and drying. (*Chem. Abs.*, **17**, 3911 (1923).)

Wiester, Stefan

ENAMEL OVEN. U. S. Pat. 1,285,682, Nov. 26, 1918.—Ledges of reinforced brickwork extend horizontally inward, one above another, from the outer wall of the oven, and support removable lining sections. (*Chem. and Ind.*, **38A**, 142 (1919).)

Wiester, Stefan

METHOD FOR COOLING ENAMEL. U. S. Pat. 1,340,353, May 18, 1920.—A method of comminuting enamel to retain its physical elasticity, color, and to eliminate separate drying, consisting of heating enamel to form a molten mass and then discharging the molten mass in a stream and subjecting the stream to a jet of air moving with sufficient rapidity to separate the molten mass into small particles and to blow the particles a sufficient distance to cool the same to such an extent that they will not adhere together. (*Jour. Amer. Ceram. Soc.* (Abs.), **3**, 691 (1920); *Chem. Abs.*, **14**, 2064 (1920); *Chem. and Ind.*, **39A**, 491 (1920).)

Wilber, F. A.

STANDARDIZED COST METHOD FOR ENAMELING INDUSTRY. *Enamelist*, **1** [10], 4 (1924).—In order to show the proper cost differential between small and large pieces, the products should be segregated into groups. For example: Group No. 1, weights or measurements to one pound or square foot; No. 2, to two pounds or square feet; No. 3, to five pounds or square feet; No. 4, to ten pounds or square feet. The number of groups will depend upon local conditions with respect to variations in size, weights,

shapes, etc. The elements of manufacturing costs are: (1) *Materials:* A base price should be used on all items. Prices over or under this established standard should be charged or credited to "material loss and gain account." (2) *Labor:* Timing of production should be made of the different groups for each operation. The difference of actual labor and the departmental standard is charged to "labor loss and gain." This forms the connecting link between the standards set up and the actual operating conditions. (3) *Overhead:* (General expenses except selling.) A budget is set up for the ensuing year and classified by operating departments. The difference between standard and actual expenditures is carried to the "overhead loss and gain" account.

Wilber, F. A.

STANDARD COSTS AS MEASURE OF PRODUCTION. *Enamelist*, **3** [1], 10 (1925).—The layout of a standard cost sheet is shown. Figures to illustrate its use are given.

Wilkinson, G. D.

GAS PRODUCES BETTER RESULTS AT LESS COST IN SHEET-IRON ENAMEL. *Jour. Amer. Ceram. Soc.*, **9**, 693 (1926).—A comparison of gas- and coal-fired sheet-iron enamel furnaces is presented. Automatic control is possible with gas with lower amount of discount ware, fewer furnace repairs, increased production capacity, and lower operating cost. Operating cost data are given. (*Chem. Abs.*, **20**, 3789 (1926).)

Williams, A. E.

DISINTEGRATION OF SODA-LIME GLASSES IN WATER. *Jour. Amer. Ceram. Soc.*, **5**, 504 (1922).—Soda-lime glasses have been treated in water at temperatures below boiling point, at boiling point, and up to 25-lb. pressure in an autoclave. Effects produced are illustrated with photographs and show that glass disintegrates, *i.e.*, cracks, spalls, and loses weight when treated at any temperature used. The rate of disintegration depends upon time, temperature, composition, and heat treatment of glass surface during forming, the latter factor apparently affecting considerably the tendency to spall or chip. Treatment given glasses conforms in many ways to treatment glass receives in service, either when sterilized as when used for food packing or continued washing and sterilizing as when used for delivering or serving food daily. The relative endurance of glasses may be studied by the methods used and standard methods of testing based upon them can be worked out. An article must stand at least six hours in boiling water without apparent disintegration or chipping to be of good quality. Spalling always appeared on the exterior only of pressed or blown ware. Disintegration of the glass is cumulative with time of treatment whether it be periodic or continuous treatment. Treating glass in hot water with increasing pressures, does not seem to give greatly increased disintegration as the temperature and pressure rises. Surfaces of blown or pressed articles are shown to be laminated rather than smooth and impervious.

Williams, R. H.

COLORED ENAMELS. *Enamelist*, **4** [1], 12 (1926).—An elementary analysis of light and color: (1) Blue, red, and yellow are simple or primary colors. (2) Green, violet, and orange are compound or secondary colors. (3) Blue and red produces violet. (4) Red and yellow produces orange. (5) Yellow and blue produces green. (6) Compound colors vary in hue according to the proportion of simple colors of which they are formed. (7) Primary colors cannot vary in hue but only in intensity. (8) White light is composed of blue, red, and yellow. The color that is missing from a compound is called the complementary color.

Williams, R. H.

ENAMEL INDUSTRY OF AUSTRALIA. *Enamelist*, **4** [10], **12** (1927).—Short review of the development of the industry in Australia.

Williams, R. H.

EARLY EXPERIMENTS. *Enamelist*, **5** [3], 16 (1927).—Excerpt from an early paper by Archard on "Vitrification of Earths by Metallic Oxides."

Willmer, H.

ENAMEL FOR COATING SURFACES OF STEAM ENGINES LIABLE TO CORROSION. German Pat. 350,770, Nov. 27, 1920.—An enamel which is not decomposed by steam contains either no alkalis, or only such as are introduced by the feldspar or cryolite used. (*Chem. and Ind.*, **41A**, 502 (1922).)

Wilson, H. F.

ENAMELING AND OTHER INDUSTRIAL OPERATIONS. British Pat. 4244, Feb. 21, 1910.—The process described refers to spraying enamel, but is also applicable to dusting, sandblasting, and to the discharge of objectionable gases or particles as in wool-sorting. The casting to be enameled is carried on a turntable which is itself carried on a carriage running in guides. The turntable is enclosed in a stationary casing connected with a suitable source of draft and provided with sleeves to receive the arms of the operator. (*Chem. and Ind.*, **30**, 424 (1911).)

***Wilson, H. F.**

ENAMELING IRON CASTINGS, ETC. See McCourt, C. D. (this *Bibliography*, p. 211).

Wilson, R. E., and Hall, F. P.

MEASUREMENT OF PLASTICITY OF CLAY SLIPS. *Jour. Amer. Ceram. Soc.*, **5**, 916 (1922).—(1) The paper emphasizes the great need of a quantitative measure of physical properties commonly included in the term "plasticity" of clays and clay slips. Various indirect methods previously suggested are likely to lead to erroneous conclusions, while measurement of the flow or apparent viscosity of clay slips made up with a constant amount of water is shown to give misleading results. (2) The work described is preliminary in nature and has been confined to a study of the properties of clay-water mixtures in the casting rather than in the molding range. In the light of these results it is recommended that, instead of the vague term plasticity, the properties of a given clay, at least for casting purposes, be expressed in terms of: (*a*) the water content required to give proper working consistency, and (*b*) the resistance of the resulting slip to small deforming forces (such as gravity). Specifically, use is made of a modified Bingham plastometer, and the figures reported are (*a*) the amount of water required to give a slip of a specified mobility, and (*b*) the yield value of the slip thus obtained. (3) The method is shown to be capable of giving quantitative figures for the yield value at constant mobility which correspond well with the customary qualitative idea as to the plasticity of clays. The amount of water required to give constant mobility varies to a surprising extent, and does not appear to bear any definite relationship to the usual classification of more or less plastic clays. It probably does parallel fairly well the shrinkage on drying. (4) Small amounts of acid or alkali are shown to have a negligible effect on the mobility of a clay slip, but a very large effect on the yield value, the variations being greater than the difference between a nonplastic kaolin and a highly plastic ball clay. This brings out the necessity and potential value of controlling the hydrogen-ion content of the water used in making the slips. (5) Some preliminary data are given on the effect of additions of flint and similar nonplastic materials to clay

slips. (6) It is recommended that an attempt be made to agree upon standard dimensions for the capillary and the desirable mobility for various purposes, and that the plastometer then be used as a standard method test in the ceramic industry.

***Wimmer, A.**

EFFECT OF TEMPERATURE AND CHEMICAL COMPOSITION ON VISCOSITY OF IRON. See Oberhoffer, P. (this *Bibliography*, p. 225).

Winklhofer and Jaenicke, Akt-Ges., Wanderer Werke

ENAMELING FURNACE. British Pat. 7839, April 1, 1909.—To prevent loss of heat, enameling furnaces may be charged and discharged by means of trolleys running on rail tracks, between the furnaces and workshops. For this purpose a transferring or traversing carriage is used, movable on a track in front of a bank of furnaces out of which rail tracks extend. The present invention consists in providing the carriage with a number of rail tracks, so that immediately after running a trolley out of the furnace onto one of the tracks, another trolley can be run into the furnace off another track. (*Chem. and Ind.*, **28**, 1130 (1909).)

***Wohlgemuth and Rewald**

ANTIMONY OXIDE. See *Chem. Trade Jour.* (this *Bibliography*, p. 65).

***Wolbach, M. O.**

THE PLASTOMETER AS INSTRUMENT FOR PROCESS CONTROL. See Bingham, E. C. (this *Bibliography*, p. 23).

STUDY OF PLASTICITY OF PAINT. See Bingham, E. C. (this *Bibliography*, p. 23).

Wolever, Franklin H.

PULVERIZING MILL. U. S. Pat. 1,468,893, Sept. 25, 1923.—A mill for pulverizing enamel stock, etc., comprising a rotative barrel formed with end walls and a circumferential wall of internal polygonal cross-section, with the segments meeting at angles of from 90 to 135°, all made of vitreous porcelain, the circumferential wall being continuous from end to end and joined to the end wall by internal dry joints, the circumferential wall being made of solid vitreous porcelain staves and being joined along integral beveled edges by internal dry joints to produce the angle specified, and means exterior to the internal faces of the joints between the beveled edges of the staves and between the end walls to hold the barrel members rigidly together. (*Ceram. Abs.*, **2**, 286 (1923).)

Wolf, Josef

WHY IT IS IMPOSSIBLE TO OBTAIN DEEP, BRIGHT, FULL COLOR TINTS IN COVER GLAZES (ENAMELS, ETC.). (*Sprechsaal*, **60**, 219 (1927)).—W. noted among the many investigations he has conducted on glazes that when he employed cover glazes as ground coats no deep bright colors were obtained as with transparent glazes. An investigation was carried out to prove whether the principle of Ostwald is true, *i.e.*, that if white predominates in large quantities of primary (full) colors, the latter will only develop weakly. A series of color shades were investigated representing all stages of enamels from opaque (white) to transparent. A large number of triaxial diagrams illustrate his method of investigation and the manner in which he proved that the color principles of Ostwald held true with enamels. The reason no deep full tints are obtained with white opaque enamels may be found in the strong reflection of such enamels. (*Ceram. Abs.*, **6**, 505 (1927); *Chem. Abs.*, **21**, 4039 (1927).)

Wolff, P.

TESTING IRON FOR SUITABILITY FOR CASTING. *Stahl u. Eisen*, **46**, 560 (1926).—Before casting a charge, a small wedge-shaped casting should be made in a sand mold.

The Brinell hardness and fracture of this piece should indicate the quality of a charge when it has been standardized against analytical and tensile tests on similar material. The sharp end of the wedge indicates the depth of the white layer that may be expected, and the upper end of the wedge the nature of the gray interior of the casting. Tensile strength, $T = H - 40/6$, where H is Brinell hardness. (*Ceram. Abs.*, **5**, 299 (1926); *Chem. and Ind.*, **45B**, 544 (1926).)

***Wolff Mfg. Corp.**

STAGING a COMEBACK WITH NEW ENAMEL FURNACES. See *Ceram. Ind.* (this *Bibliography*, p. 55).

Wolfram, H. G.

REMELTING SCRAP REDUCES BLISTERING OF CAST-IRON ENAMELS. *Ceram. Ind.*, **5**, 134 (1925).—Three main possibilities as to cause of blistering: (1) Gas is taken up in the blast furnace, due to difference in operating conditions in northern furnaces. It has been assumed that this gas is removed on repeated meltings. (2) Some element not shown by ordinary analysis might be present in the pig and in some hidden way is responsible for the trouble. (3) The trouble may lie in the presence of graphite on the surface. Making test pieces of remelted scrap gave the following results: (*a*) Plates cast from the first melting in the electric furnace blistered, but not as badly when enameled by the dry process as by the wet process. (*b*) Remelted scrap from both the electric furnace and cupola show no blisters when enameled by the dry process, and a decided reduction of blistering in the wet process. It appears that remelting the iron several times reduces blistering. (*Ceramist*, **6**, 610 (1924).)

Wolfram, H. G.

EFFECT OF ZIRCONIA IN ENAMELS FOR SHEET STEEL. *Jour. Amer. Ceram. Soc.*, **7**, 1 (1924).—This paper deals with the results obtained from a study of the effect of additions of zirconium oxide to enamels for sheet iron and steel. The work includes additions of the zirconia to the raw smelter batch of both the ground and cover enamels; also the substitution of the zirconia for tin oxide in the mill batch. Several tests were used to determine its effect on some of the properties of the enamels such as resistance to impact, thermal shock, and acid. The use of zirconia in kitchenware enamels is beneficial in its effect upon the essential properties of the enamel. It was found that the resistance to acid was increased in agreement with the statement of Staley. The enamels were made stronger and more resistant to thermal shock here confirming the investigation of Fritz Kraze. It was also found, in accordance with Wenning's conclusions, that zirconia makes a more viscous enamel, gives a good white body with opacity as good as tin oxide. The results on opacity do not agree with those of Morgan and Charles, Jr., that zirconia could not be used as a substitute opacifier for tin. This disagreement may be due to two causes: (1) they give no statement as to the source

ENAMEL USED

	Ground coat	White Cover Enamel
Borax	32.0	25.5
Feldspar	29.0	25.0
Quartz	19.0	21.0
Soda ash	9.0	3.5
Sodium nitrate	5.0	3.0
Fluorspar	4.7	
Cobalt oxide	0.8	
Manganese oxide	0.4	
Cryolite		14.0
Antimony oxide		3.0
Zinc oxide		5.0

of zirconia used and may have had an inferior grade; (2) the composition of the white used is not in agreement with the base white of this investigation. The white base used by Morgan and Charles, Jr., was a high fluoride enamel while the base used in this work was an antimony enamel high in cryolite, also containing zinc oxide. A further field of investigation could be suggested in which the compositions of the enamel and combinations of ground and cover coats could be worked out to give very satisfactory results. The ground coat frit was ground in approximately ten-pound batches in a ball mill with a constant mill addition of 8%, 1.75% borax (sol), and 50% water. The additions of zirconia were made in the raw frit batch. The base ground coat No. 1 was used, also additions of 2.5% zirconia to the base smelter for No. 2, and 5.0% zirconia to the base formula for No. 3. The first Series A consisted of the base enamel (given above) with additions of 2.5% and 5.0% zirconia to the smelter batch; in series A 7% tin oxide was used in the mill. Series B consisted of the base enamel with 4.0% and 8.0% substitutions to the mill batch of zirconia for tin oxide. In all cases a constant mill addition of 6.0% clay, 0.25% magnesium carbonate, and 60.0% water was used. (*Chem. Abs.*, **18,** 890 (1924); *Chem. and Ind.*, **43B,** 218 (1924).)

***Wolfram, H. G.**

EFFECTS OF COMPOSITION ON THE PROPERTIES OF GROUND-COAT ENAMELS FOR SHEET STEEL. See Harrison, W. N. (this *Bibliography*, p. 147).

QUESTION OF ANNEALING PORCELAIN PARTS PROVED TO BE VERY INTERESTING. See *Enamelist* (this *Bibliography*, p. 106).

Wolfram, H. G., and Harrison, W. N.

DEVELOPMENT OF JEWELRY ENAMELS. *Jour. Amer. Ceram. Soc.*, **7,** 857 (1924).—A series of thirty-three enamels having a constant melted portion of 20 silica, 30 lead oxide, and 5 soda, and a variable melted portion of 45 parts was prepared and applied to shallow cells in copper plates. Several of this field were used as fluxes in producing some transparent colored enamels. Besides details of technique, the most important conclusions are: (1) All the better enamels contained boric acid plus lead or silica or both in the variable portion. (2) Those having the highest ratio of lead oxide to silica were superior. (3) In those containing soda or potash, the latter seemed more desirable. (4) Enamels ground to pass 80-mesh but retained on 100-mesh sieves produced the best results. (5) The color produced by a given stain was affected by the composition of the enamel. (6) The gloss, texture, and general appearance of the enamel were affected by the coloring agent. (7) Melting the enamel at a temperature high enough to produce a very fluid melt most effectively eliminates bubbles. In the case of highly refractory or viscous enamels remelting was beneficial. (8) The oxides of chromium and copper may be substituted for the salts of these metals as stains without changing results. (*Chem. Abs.*, **19,** 713 (1925); *Chem. and Ind.*, **44B,** 133 (1925).)

Wolfram, H. G., and Harrison, W. N.

EFFECTS OF COMPOSITION ON PROPERTIES OF SHEET-STEEL ENAMELS. *Jour. Amer. Ceram. Soc.*, **8,** 735 (1925).—This paper deals entirely with white-cover enamels applied to a standard ground coat of relatively low coefficient of expansion which is typical of commercial practice. The following conclusions are based on results obtained: (1) The coefficient of expansion is only one of the major factors affecting the ability of enamels to resist mechanical and thermal shock. (2) Resistance to quenching and to impact on parts of ware free to deflect, increases with decreasing expansivity of the enamels. (3) Resistance to impact on a curved surface, or part of ware not

free to deflect increases slightly with increasing expansivity. (4) Boric oxide and sodium oxide are conducive to greater opacity in some enamels when these constituents are substituted for a part of some of the materials ordinarily used as opacifying agents. (5) Replacing the customary flint content of the enamels by feldspar increases the resistance to impact-on-edge and decreases the resistance to impact-on-center, decreases opacity and resistance to quenching and acid attack. (6) In most cases replacing the usual feldspar content of the enamels by flint greatly increases resistance to quenching and acid attack and decreases opacity. This also slightly decreases resistance to impact on edge and center. (7) Enamels containing both silica and feldspar were on the whole, most satisfactory for general use, but enamels having certain excellent properties, making them more suitable for special purposes, were found in Series I and III. (8) While generalities may be drawn regarding the usual effect of substituting certain constituents for others in enamel, this effect sometimes varies with the type of enamel used. Plan of investigation: Series I, refractory (all feldspar), Series II, refractory (feldspar and flint), and Series III, refractory (all flint). In each series various fluxes and opacifiers were substituted systematically one for another. The enamels were applied to 8-inch steel dinner plates; tested for resistance to thermal shock and acid attack; examined for relative opacity and subjected to impact tests.

GROUND COAT

Batch		Mill	Lb.
Borax	33.3	Frit	100
Feldspar	23.8	Clay	7
Flint	21.9	Borax sol.	1.5
Soda nitrate	7.1	Water	50.0
Potassium nitrate	4.3		
Fluorspar	4.2		
Clay	3.9		
Cobalt oxide	0.4		
Manganese oxide	.7		
Nickel oxide	.4		

Enamelist, **2** [5], 24 (1925); *Chem. Abs.*, **20**, 808 (1926); *Chem. and Ind.*, **45B**, 128 (1926).

Wolfram, H. G., and Turk, R. H.

OBSERVATIONS ON AGING OF ENAMELS. *Jour. Amer. Ceram. Soc.*, **10**, 334 (1927).—The tendency toward more rapid production of enameled ware has reduced to a minimum the time allowed in most plants for aging of enamels. Aging of the enamel slip allows the clay to become thoroughly slaked, absorb the larger enamel particles, and thus prepare it for its cohesion to the metal base. Aging or soaking of the clay before use is an excellent substitute for part of the time consumed in aging the enamel slip. Observations of results obtained in commercial application of enamels has lead to the following conclusions: (1) Enamels should be aged before use in order to gain the full benefit of the adsorption properties of the clay and enamel colloids. (2) If the proper time of aging of enamels cannot be allowed at least the clay should be brought to a fine state of subdivision by aging or soaking in water. (3) If aging is not allowed in some form, the enamel usually is not as easily applied with the ordinary handling encountered in average production. (4) If aging of the clay is allowed there is a quicker turnover of the stock enamel in the mill room. (*Ceram. Abs.*, **6**, 264 (1927); *Chem. Abs.*, **21**, 2775 (1927); *Chem. and Ind.*, **46B**, 629 (1927).)

***Wolverine Porcelain Enameling Co.**

NEW IDEAS "PEP UP" ENAMELING PLANT. See *Ceram. Ind.* (this *Bibliography*, p. 56).

Woog, P., and Delage, M.

PROCESS OF ENAMELING IN ONE STAGE. French Pat. 401,543, July 29, 1908.—An acetylene flame is directed onto the spot where the enamel is required and the finely ground enamel is also projected on the same spot. (*Chem. and Ind.*, **28**, 1130 (1909).)

***Woolfolk, A. P.**

REFRACTORY VALUE OF ENAMELS. See *Ceramist* (this *Bibliography*, p. 62).

Worsham, Edgar A.

PICKLE-ROOM PRACTICE AT PEMCO. *Ceram. Ind.*, **5**, 429 (1925).—Description of the process as carried out in the plant of the Porcelain Enamel and Manufacturing Co. at Baltimore, Md. A solution of one-third 20°Bé muriatic acid and two-thirds water is used. This is agitated by compressed air. No tests other than practical knowledge are made of the acid strength. It is possible to pickle 80,000 to 100,000 square feet of sheet iron before making a new solution although it may be necessary to add a carboy or two of acid to renew the strength. The soda solution is made new each day using about five pounds to a tank 8 by $3^1/_2$ by $2^1/_2$ feet. This solution is heated to boiling. The borax solution is made by using 15 pounds borax (tank same size as soda solution), adding 5 pounds borax daily, and changing tank completely every seven or eight days.

***Wrought Iron Range Co.**

GROUND-COAT FIRING ON STEEL. See Jansen, F. (this *Bibliography*, p. 162).

NEW AUTOMATIC SPRAY BOOTH. See *Ceram. Ind.* (this *Bibliography*, p. 55).

PRODUCTION IN ENAMELING SHOP INCREASED. See *Ceram. Ind.* (this *Bibliography*, p. 51).

Wry, T. A.

ENAMELING OVEN AND ASSOCIATED CONVEYERS. U. S. Pat. 1,532,017, March 31, 1925.—Enameling apparatus comprising a high temperature oven having a wall provided with a plurality of longitudinally extending apertures, conveyer members in the oven extending between the apertures, means exterior of the oven for moving conveyer members through oven, and connections through apertures between conveyer members and means. (*Chem. Abs.*, **19**, 1763 (1925).)

Wry, T. A.

TRANSPARENT ENAMELS. See *Bull. Amer. Ceram. Soc.* (this *Bibliography*, p. 41).

Wupperman, H.

SHEET-METAL UTENSILS. Book, published 1907, Karlsruhe. Economics of German enameled-ware trade.

Yardley, J. L. McK.

VITREOUS ENAMELING IN THE ELECTRIC FURNACE. *Elec. World*, **82**, 327; *Chem. Met. Eng.*, **29**, 55 (1923).—Recent furnace improvements include Carborundum or Carbofrax brick muffle, intermittent gas fire, and electric heat. Carborundum has $^1/_8$ the thermal resistance of fire clay. In the intermittent furnace, gas is burned directly in the chambers and heated above the required temperature. Then the gas is turned off and the enamel is fused under falling temperature. With 500 B.t.u. gas at 50 cents the fuel cost with intermittent gas furnace is 9 cents per 100 lbs. or 10 cents per

100 sq. ft. of surface. Cost in electric furnace will be as low if power cost is 1 cent per kw.-hr. Furnaces for watch dials, bath tubs, and sheet iron are described and other cost data given. (*Ceram. Abs.*, **3**, 116 (1924); *Chem. Abs.*, **17**, 3409 (1923).)

York, D. A., and Tinker, J. A.

ENAMELING STEEL, ETC. U. S. Pat. 1,017,360, Feb. 13, 1912.—The process of enameling steel, etc., which consists in applying a coating comprising a plastic mixture of powdered glass, borax, saltpeter, feldspar, cobalt oxide, and clay; firing the coated steel; applying to the first coat a coating comprising a plastic mixture of borax, feldspar, soda, saltpeter, silica, tin oxide, kriolita, and clay; and again firing the coated steel. (*Chem. Abs.*, **6**, 920 (1912).)

Zahn, O.

ENAMELING AND ANNEALING, OVENS EMPLOYED THEREFOR. British Pat. 27,048, Nov. 28, 1906.—The working chamber in which the enameling is carried out is first heated internally by means of hot gases on their way to the chimney. These gases are shut off by means of dampers, and passed through flues located in the walls of the working chamber. In order to prevent accidental entry of the gases into the working chamber through the dampers not fitting properly, means are inserted between the parts to the chamber and the chimney, which draw the gases from the former into the latter; or else an overpressure of some indifferent gas may be created in the chamber. (*Chem. and Ind.*, **26**, 1093 (1907).)

Zahn, O.

ENAMELING AND ANNEALING. British Pat., 28,746, Dec. 17, 1906.—The working chamber in which the enameling and annealing are to be carried out, is first raised to the required temperature by heating it both internally and externally by means of furnace gases; the flue leading from the interior of the chamber to the chimney is then closed by means of a damper, so as to cause the flame to circulate only around the exterior of the chamber, which is thus kept at the required temperature. This procedure also serves to remove the gases remaining in the chamber through the flue leading from the furnace, and any injurious action on the ware is thus prevented. (*Chem. and Ind.*, **26**, 968 (1907).)

Zahn, O.

PROCESS AND FIRING OVEN, ESPECIALLY APPLICABLE TO ENAMELING. French Pat. 460,104, July 7, 1913.—To suppress heat at certain points where it would be injurious to enameled objects fired in a muffle oven, the excess heat may be absorbed by accumulating material or by special cooling devices at these points, or the heat which surrounds the muffle may be prevented from acting on the cover, or part of the muffle, especially the cover, may be treated differently with regard to local heating. These objects are attained by prolonging the side walls of the muffle up to the arch of the heating chamber, by shielding the cover of the muffle with an insulating material to prevent radiation of heat toward the interior; by diminishing the radiation from the hot gases through the side walls toward the upper part of the muffle by means of insulating or other material or by curving the walls outward; by the provision of a cooling conduit, or a space connected with a cooling chamber by suitable valves, above the muffle; and by applying heat only at certain points and not uniformly over the component parts of the oven. Also U. S. Pat. 1,124,380, Jan. 12, 1915. (*Chem. and Ind.*, **33**, 25 (1914); *ibid.*, **34**, 231 (1915); *Chem. Abs.*, **9**, 701 (1915).)

Zahn, O.

FURNACE FOR ENAMELING. German Pat. 263,518, Sept. 27, 1912.—Process of firing and a furnace for enameling, with prevention of direct-flame contact. (*Chem. Abs.*, **8,** 227 (1914).)

Zahn, O.

MUFFLE FURNACE FOR ENAMELING. German Pat. 267,801, Feb. 27, 1913; addition to German Pat. 263,518.—Constructional details of a muffle furnace for enameling, with prevention of direct contact of the flame. (*Chem. Abs.*, **8,** 1653 (1914).)

Zahn, O.

ENAMELING MUFFLES. *Keram. Rundschau*, **19,** 30; *Stahl u. Eisen*, **31,** 308.—A criticism of previous work on the same subject in which objection is raised to the use of grate and semigas fired muffles and in which the gas-fired regenerative system is strongly advocated. (*Chem. Abs.*, **5,** 1671 (1911).)

Z. angew. Chem., **33** [1], 200 (1920).

ARTIFICIAL CRYOLITES.—Description of patent granted to the firm of J. L. Eckelt. HF is drawn from the vessel in which it is generated by a water-jet vacuum-pump actuated by a solution of Na_2AlO_3. The cryolite separates as a fine crystalline powder which does not clog the pump. The advantages of the method are: (1) attainment of the end-product by two manipulations (the fusion of kaolin and soda and the action of HF on these); (2) great simplification of equipment and decrease of attendant costs; (3) no escape of HF from the apparatus and hence plants can be erected in cities. (*Jour. Amer. Ceram. Soc.* (Abs.), **3,** 1012 (1920).)

Ztg. Blechind., **12,** 243.

ENAMELING ROLLED IRONWARE. (*Rep. der. Tech. Lit.*, p. 119 (1882–1884).)

Zerzog, J.

ENAMELING IRON AND OTHER METALS. British Pat. 15,129, July 22, 1899.—The enamel consists of red lead, borax, and flint, to which may be added magnesia, fluorspar, or broken glass, the exact composition depending upon whether it is required to be of a fusible or refractory character. Colored oxides may also be added. The mixture is fused, cooled in water, and ground to a thin paste. The articles to be enameled are dipped into this paste, and then dried and fired in a muffle. (*Chem. and Ind.*, **18,** 1020 (1899).)

Ziegenbruch, L.

PIGMENTS, COLORING MATTERS, OR "LUSTERS" FOR PORCELAIN, GLASS, ENAMEL, ETC. British Pat. 9353, May 21, 1900.—Solutions of boric esters are incorporated with the pigments or glazes, and, in the firing process, form borates, which react on the metallic oxides or metals present. Thus cobalt luster, by this means, gives a blue on enamel, while gold lusters furnish rose-pink to purple shades according to the amount of metal present. (*Chem. and Ind.*, **20,** 477 (1901).)

Zies, E. G.

METHODS OF GLASS ANALYSIS, WITH SPECIAL REFERENCE TO BORIC ACID AND TWO OXIDES OF ARSENIC. See Allen, E. T. (this *Bibliography*, p. 3).

Zimmerli, Wm.

ENAMELED STEEL INDUSTRY. *Trans. Am. Inst. Chem. Eng.*, **11,** 299 (1918).—Difficulties of the industry in wartime are discussed. (*Jour. Amer. Ceram. Soc.* (Abs.), **4,** 169 (1921); *Chem. Abs.*, **14,** 3772 (1920).)

***Zimmerman, A. C.**

COATING ALUMINUM OR MAGNESIUM OR THEIR ALLOYS WITH SILICATES. See Daniels, S. (this *Bibliography*, p. 78).

Ziureck

ENAMELING OF COOKING VESSELS. *Bayr. Gwbl.*, p. 48 (1872). (*Rep. der Tech. Lit.*, p. 405 (1869–1873).)

ENAMELING OF COOKING VESSELS. *Dt. Ind. Z.*, p. 474 (1871). (*Rep. der Tech. Lit.*, p. 405 (1869–1873).)

Zocher, H., and Reinicke, F.

ORIGIN OF IMPRESSION OF LUSTER. *Zeits. f. Physik.*, **33**, 12 (1925).—After a brief mention of the literature on the subject, reference being made to the early work of Wundt and of the recent work of Esslen and of Bancroft, the authors discuss in general terms the cause of luster or the impression of luster which may be obtained by the employment of suitably arranged surfaces. These surfaces may consist of material having a mat surface. From a physical point of view, luster is defined as incomplete regular reflection. From a consideration of the nature of the surface a distinction is drawn between reflection luster and mat luster. The luster of diamond, glass, or water comes in the first class, and mother-of-pearl and fat in the second. Surfaces which show reflection luster when considered on a very small scale (like the human skin) may show a mat reflection on a large scale. The consideration of the different circumstances (variation of color, light, and shade) which lead to the impression of luster are next discussed. Metallic reflection is due to intensity of luster while a substance like barium sulphate may diffusively reflect nearly all the light which falls on it without the impression of luster. The perception of solidity is next discussed, and the effect of stereoscopic vision. The remainder of the paper gives numerous examples of methods of producing the illusion of luster. Many of these methods are employed in the textile industry; *e.g.*, Schiller or changeant fabric and the moiré effect may be cited. (*Ceram. Abs.*, **5**, 43 (1926).)

Zschimmer, E.

APPLICATION OF GLASS, ENAMELS, AND GLAZES. I. *Ceram. Ind.*, **4**, 448 (1925).—R. Froelich divides the oxides into the following groups to use in calculating the melted composition of enamel: (G) *Basic Substances:* per cent content of SiO_2, MgO, CaO, as calculated; and per cent content of CaF_2, $MgSO_4$, half of calculated. (F) *Flux:* per cent content of B_2O_3, Na_2O, K_2O, as calculated; and per cent content of PbO, as calculated for basic enamels, half of calculated for covering enamels; per cent content of CaF_2, cryolite, and ammonium carbonate, half of calculated. (D) *Acid Substances:* per cent content of Al_2O_3, SnO_2, Sb_2O_3, and coloring oxides, as calculated; per cent content of PbO (in covering enamels and cryolite), half of calculated. For enamels for iron, the following percentages prevail:

	(G %)	(F %)	(D %)
Basic tin enamel	52	37	11
White surface	47	31	22
Colored surface	49	33	18
White shiny surface	53	33	14
Glaze	56	35	9
Acid-proof white enamel	56	26	18
Lead flux for ovens	19	45	36

(The usual mill clay addition is included in the percentage composition.)

Zschimmer, E.

APPLICATION OF GLASS, ENAMELS, AND GLAZES. II. *Ceram. Ind.*, **5**, 34 (1927).—Enamels, glazes, and glass when studied from a purely physical-chemical standpoint, are nothing more or less than chosen points within one of the possible combinations of a few substances with which we are all familiar. In this article, Z. makes a plea for ceramic manufacturers to express their formulas, recipes, and batches in one common "language." He suggests notations by percentage composition.

Zschimmer, E.

CHEMICAL FORMULA FOR A GLASS, GLAZE, OR ENAMEL. III. *Ceram. Ind.*, **5**, 128 (1925).—The differences between constant and variable raw materials and their effect on the batch are explained. Advice on mill additions is given.

Zschimmer, E.

CHEMICAL RELATIONS OF GLASS, GLAZES, AND ENAMELS. IV. *Ceram. Ind.*, **5**, 225 (1925).—Valuable information is gained by studying the field of various glasses and the manner in which this information can be obtained is explained.

Zschimmer, E.

GLASSES, GLAZES, ENAMELS. V. *Ceram. Ind.*, **5**, 518 (1925).—In this discussion it is shown how the general formula of: $\left.\begin{matrix}B_2O_3\\SiO_2\end{matrix}\right\}Al_2O_3\text{–}R_2O\cdot RO$ of resistance glasses proves a fundamental basis for developing glasses. This same formula occupies the same position in the development of enamels. Its use for this purpose is explained.

Zschimmer, E.

GLASS, GLAZES, ENAMELS. VI. *Ceram. Ind.*, **6**, 368 (1926).—The relationship between glasses, glazes, and enamels is set forth in formula form. This article is the last of the series.

Zschimmer, E.

CHEMICAL COMPARISON OF GLASSES, ENAMELS, AND GLAZES. *Sprechsaal*, **57**, 274, 287, 299; *Jour. Soc. Glass Tech.*, **8**, 246.—Z. gives tables showing the formulas of ground coats and cover coats for sheet iron. The enamels are compared to resistant glasses. Limits of the constituents for glasses, enamels, and glazes for various purposes are given, with reasons for the limits. (*Ceram. Abs.*, **5**, 45 (1926); *Chem. Abs.*, **19**, 2116 (1925).)

Zulauf, R.

PRODUCTION OF ENAMELED WRITING PLATES. German Pat. 373,568, June 11, 1921.—Compositions for enameling sheet metal for use in the manufacture of writing plates (substitutes for writing slates or blackboards) contain small quantities of a zirconium compound, *e.g.*, 4 to 5% of zirconium fluoride, with or without a small quantity of an alkaline compound, *e.g.*, sodium carbonate, in addition to the usual constituents. (*Chem. and Ind.*, **42A**, 1023 (1923).)

Zulauf, R.

ENAMEL-COATED WRITING TABLETS. U. S. Pat. 1,438,154, Dec. 5, 1922.—A first enamel coating of ordinary composition is applied to sheet iron and "stoved" and a finishing enamel is then "stoved" upon the first coat. The finishing coat is prepared by grinding a fused enameling mixture of ordinary composition with a considerably larger addition of clay than usually employed. This second coat gives a dull or mat finish. (*Ceram. Abs.*, **2**, 122 (1923); *Chem. Abs.*, **17**, 864 (1923).)

Zulauf, R.

ENAMELED WRITING TABLETS. U. S. Pat. 1,497,397, June 10, 1924.—A finishing enamel to which the usual amount of clay has been added is stoved on an enamel ground at a temperature about 200° lower than the usual temperature for finishing enamels. (*Chem. Abs.*, **18,** 2413 (1924); *Chem. and Ind.*, **43B,** 675 (1924).)

Zwerman, Carl H.

ENAMEL SIFTING APPARATUS. U. S. Pat. 707,490, August 19, 1902.—An apparatus for enameling bathtubs or other metal objects. The article to be enameled is supported on a table which can be tilted and revolved, and above which a number of sifting boxes adapted to contain enamel are mounted. Each box is provided with independent jarring arrangements, and is free from direct connection with the other boxes. (*Chem. and Ind.*, **21,** 1232 (1902).)

Zwermann, T.

ENAMELING SHEET METALWARE. U. S. Pat. 517,992, April 10, 1894.—The process of enameling sheet metalware, which consists in applying to the articles a ground enamel mixed with prepared glass frits and a suitable metallic oxide, next drying and fusing the same, and then applying a second transparent enamel or glaze, and drying and fusing the same.

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SUBJECT INDEX[1]

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